## A3.1 Hawaii's Categories for Recycled Water

The State of Hawaii uses three categories of recycled water which are based on regulatory definitions, and include *R-1*, *R-2*, and *R-3* Recycled Water. The categories indicate the level of treatment required for a specific beneficial use. In addition to the required treatment levels, each beneficial use has required monitoring regulations, setback distances and other criteria that must be met. This criterion is listed in the Guidelines for the Treatment and Use of Recycled Water (Hawaii, 2002). A summary for each of the three categories is shown below, including definitions from Hawaii's Regulations for Reuse (Chapter 62 of Title 11, State of Hawaii 2004).

### A3.1.1 Hawaii's R-1 Recycled Water

Hawaii's R-1 recycled water category has the highest recycled water quality standards relative to the other two categories. For R-1 standards to be met, Hawaii requires that wastewater effluent be treated by means of oxidization, filtration, and disinfected to a significant reduction in viral and bacterial pathogens. Examples of potential reuses include Unrestricted Urban Reuse, Restricted Recreational Reuse, and Agriculture Reuse (Food Crops and Non-Food Crops). Specific uses of R-1 level recycled water that may be applicable to Guam in the future include any form of irrigation of golf courses, parks, elementary school yards, and residential landscaping. Hawaii has no restrictions on application rates, operation times, or potential human contact when irrigating with R-1 water. TableA3-1 below details the standards and criteria adapted from Chapter 62 of Title 11 (Hawaii, 2004) and the Guidelines for the Treatment and Use of Recycled Water (Hawaii, 2002).

Table A3-1: Hawaii's R-1 Recycled Water Treatment Standards and Approved Specific Beneficial Reuses. (Adapted from Guidelines for the Treatment and Use of Recycled Water, Hawaii 2002 and Chapter 62 of Title 11, 2004).

| Treatment Standards and Criteria (Oxidized, Filtered and Disinfected) | Examples of Approved Specific Beneficial Reuses that may Eventually Become Applicable on Guam |
|---|---|
| A. The disinfection and filtration processes must demonstrate to inactivate and/or remove 99.999 percent of the plaque-forming units of the F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least resistant to disinfection as polio virus may be used for purposes of demonstration; and<br><br>B. A disinfection process that limits the concentration of fecal coliform bacteria to the following criteria:<br><br>1.) The median density measure in the disinfected effluent does not exceed 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed; and<br><br>2.) The density does not exceed 23 per 100 milliliters in more than one sample in any 30-day period; and<br><br>3.) No sample shall exceed 200 per 100 milliliters.<br><br>C. For granular media filtration units, the effluent turbidity shall not exceed 2.0 nephelometric turbidity units (NTU). For membrane filtration units, the effluent turbidity limitations shall be determined by the director on a case-by-case basis. | • Any form of irrigation for food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop.<br><br>• Any form of irrigation served by fixed irrigation system supplied by buried piping for golf courses, parks, playgrounds school yards, athletic fields, road sides/medians, and residential property that is managed by an irrigation supervisor.<br><br>• Toilet and Urinal Flushing<br><br>• Fish Hatchery Basins<br><br>• Landscape impoundments with decorative fountains<br><br>• Air Conditioning Systems<br><br>• Commercial and Public Laundries<br><br>• Industrial Processes with Exposure to Workers |

In addition to the standards and criteria listed above in Table A3-1 for R-1 recycled water, regulations require that there shall be no irrigation within a minimum of 50-feet of any drinking water supply, and drainage shall be controlled to prevent recycled water from coming within 50-feet of a drinking water supply.

### A3.1.2 Hawaii's R-2 Recycled Water

R-2 recycled water has a slightly lower quality relative to R-1 recycled water, and must be oxidized and disinfected to meet Hawaii's requirements for various beneficial reuses. R-2 recycled water can only be used under restricted circumstances where human contact is minimized. Strict regulations for land application rates, in addition to outer periphery of irrigated areas, are regulated. Table A3-2 below details the standards and criteria adopted from Chapter 62 of Title 11 (Hawaii, 2004) and the Guidelines for the Treatment and Use of Recycled Water (Hawaii, 2002).

Table A3-2: Hawaii's R-2 Recycled Water Treatment Standards and Approved Specific Beneficial Reuses. (Adapted from Guidelines for the Treatment and Use of Recycled Water, Hawaii 2002 and Chapter 62 of Title 11, 2004).

| Treatment Standards and Criteria (Oxidized and Disinfected) | Examples of Approved Specific Beneficial Reuses that may Eventually Become Applicable on Guam |
|---|---|
| A. The following fecal coliform bacteria densities must be met:<br><br>1.) The median density measured in the disinfected effluent does not exceed 23 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed; and<br><br>2.) The density does not exceed 200 per 100 milliliters in more than one sample in any 30-day period. | • Subsurface irrigation for landscape and turf at parks, elementary school yards, golf courses, and pastures for milking and other animals.<br><br>• Any form of irrigation for sod (not installed by the general public), trees grown for timber of firewood (not harvested by the general public), landscape on cemeteries and around freeways, and restricted access golf courses.<br><br>• Structural and non-structural firefighting, industrial boiler feed, washing aggregate and making concrete, cooling or air conditioning system without tower, evaporative condenser, spraying, or other features that emit vapor or droplets. |

In addition to the standards and criteria listed above in Table A3-2, the utilization of R-2 recycled water by means of spray irrigation requires that the outer periphery of the irrigated area is not within 500-feet of a residence property or a place where public exposure is likely such as a park. Several other criteria must be followed when irrigating with R-2 recycled water. The criteria states that there shall be no irrigation within a minimum of 100 feet of any drinking waster supply, and spray irrigation shall be performed during periods beginning when the area is closed to the public and ended at least one hour before the area is opened to the public. Direct, overspray, or runoff must not contact a drinking fountain, table, chair, bench, barbeque area, or any area with frequent human contact. Unlike spray irrigation with R-2 recycled water, subsurface irrigation with R-2 recycled water can be performed at any time. Additional regulations on specific uses of R-2 water can be found in Chapter 62 of Title 11.

### A3.1.3 Hawaii's R-3 Recycled Water

R-3 recycled water has the lowest quality relative to the other two categories, and is undisinfected secondary treated recycled water. R-3 water can only be utilized where there is no potential for human contact. Table A3-3 below details the standards and criteria adopted from Chapter 62 of Title 11 (Hawaii, 2004) and the Guidelines for the Treatment and Use of Recycled Water (Hawaii, 2002).

Table A3-3: Hawaii's R-3 Recycled Water Treatment Standards and Approved Specific Beneficial Reuses. (Adapted from Guidelines for the Treatment and Use of Recycled Water, Hawaii 2002 and Chapter 62 of Title 11, 2004).

| Treatment Standards and Criteria (Oxidized) | Examples of Specific Beneficial Reuses that may Eventually Become Applicable on Guam |
|---|---|
| A. Must meet Hawaii's standards associated with Undisinfected Secondary Treatment. | • Surface, drip, subsurface irrigation of feed, fodder and fiber crops, and pasture for animals not producing milk for human consumption.<br>• Surface, drip or subsurface irrigation of non-food bearing trees, provided no irrigation with recycled water occurs for a period of 14 days prior to harvesting or allowing access by the general public.<br>• Surface, drip or subsurface irrigation of seed crops that are not eaten by humans.<br>• Surface, drip of subsurface irrigation of orchards and vineyards where the recycled water does not come into contact with the edible portion of the crop. |

In addition to the beneficial uses listed above in Table A3-3, specific uses for R-3 recycled water at water recycling facilities are listed in the Guidelines for the Treatment and Use of Recycled Water (Hawaii, 2002).

As stated in the Rules Amending Chapter 62, Title 11 (Hawaii, 2004), not-to-exceed BOD5 and TSS concentrations are regulated by the State of Hawaii, regardless if the effluent is to be used for a beneficial use or not. These concentration limits are listed below in Table A3-4.

Table A3-4: $BOD_5$ and TSS limits for all WWTPs operating on Hawaii. (Chapter 62 of Title 11, Hawaii 2004).

| $BOD_5$[1] | Total Suspended Solids[1] |
|---|---|
| For wastewater treatment works with design flows greater than or equal to 100,000 gallons per day, the owner or operator shall perform composite sampling at least weekly. | For wastewater treatment works with design flows greater than or equal to 100,000 gallons per day, the owner or operator shall perform composite sampling at least weekly. |
| For wastewater treatment works with design flows less than 100,000 gallons per day, the owner or operator shall perform grab sampling at least monthly. | For wastewater treatment works with design flows less than 100,000 gallons per day, the owner or operator shall perform grab sampling at least monthly. |
| The $BOD_5$ in the effluent from a treatment works shall not exceed 30 milligrams per liter based on the arithmetic average of the results of the analyses of composite samples. | The Total Suspended Solids in the effluent from a treatment works shall not exceed 30 milligrams per liter based on the arithmetic average of the results of the analyses of composite samples. |
| The $BOD_5$ in the effluent from a treatment works shall not exceed 60 milligrams per liter based on a grab sample. | The Total Suspended Solids in the effluent from a treatment works shall not exceed 60 milligrams per liter based on a grab sample. |

[1] –These are minimum standards that are required to be met by all Hawaii WWTPs, regardless if the treated effluent is to be recycled and utilized for beneficial uses.

The tables presented above do not detail additional requirements and criteria that are required for various beneficial reuse options and include irrigation application plans, vector control, monitoring, record keeping, public information, and labeling and signage. Furthermore, reliability requirements for wastewater treatment plants generating recycled water for beneficial uses are also detailed in Chapter 62 of Title 11 (Hawaii, 2004).

## A3.2 California's Categories for Recycled Water

The State of California uses four categories of recycled water which are based on regulatory definitions and include *Disinfected Tertiary, Disinfected Secondary – 2.2, Disinfected Secondary – 23, and Undisinfected Secondary* Recycled Water. Similar to Hawaii regulations, the categories indicate the level for which the recycled water must be treated to, and the associated potential beneficial end use of the recycled water. In addition to the required treatment levels, each beneficial use has specific monitoring regulations, setback distances and other criteria that must be met. This criterion is listed in the California Health Laws Related to Recycled Water (California 2001). A summary for each of the four categories is presented below, including definitions from Title 22 and 17 of the California Code of Regulations (California, 2001).

### A3.2.1 California's Disinfected Tertiary Recycled Water

This category has the highest water quality relative to the other three categories. California requires treatment through oxidization, coagulation, filtration, and disinfection to meet the disinfected tertiary recycled water standards. Examples of potential reuses include Unrestricted Urban Reuse, Agriculture Reuse (Food Crops), and Unrestricted Recreational Reuse. Specific uses that may be applicable for Guam in the planning horizon include irrigation of golf courses and agricultural land. Similar to Hawaii's R-1 regulations, California has no restrictions on application rates, operation times, and potential human contact when irrigating with disinfected tertiary recycled water. However, requirements on set-back distance and monitoring are required, and will be further discussed below. Table A3-5 below details the standards and criteria adapted from the California Health Laws Related to Recycled Water (California, 2001) and Title 22 and 17 of California Code of Regulations (California, 2001).

Table A3-5: California's Disinfected Tertiary Recycled Water Standards and Approved Specific Beneficial Reuses. (Adapted from California Health Laws Related to Recycled Water, 2001 and Titles 22 and 17 of California Code of Regulations, 2001).

| Treatment Standards and Criteria (Oxidized, coagulated, filtered, and disinfected) | Examples of Specific Beneficial Reuses that may Eventually Become Applicable on Guam |
|---|---|

| | |
|---|---|
| A. The filtered wastewater must be disinfected by either:<br><br>1.) A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measure at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow.<br><br>2.) A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least resistant to disinfection as polio virus may be used for purpose of the demonstration.<br><br>B. The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last seven days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 100 milliliters in more than one sample in any 30 day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters.<br><br>C. The turbidity of the influent to the filters is continuously measured, requiring;<br><br>1.) The influent turbidity does not exceed 5 NTU for more than15 minutes and never exceeds 10 NTU, and;<br><br>2.) Filter effluent turbidity does not exceed and average of 2 NTU. | • Any form of irrigation for food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop.<br><br>• Any form of irrigation for unrestricted access golf courses, parks, playgrounds school yards, and residential landscaping.<br><br>• Unrestricted recreational impoundments where human exposure to the recycled water is allowed.<br><br>• Toilet and Urinal Flushing<br><br>• Industrial processes that may come into contact with workers.<br><br>• Commercial Laundries<br><br>• Structural Firefighting<br><br>• Decorative Fountains<br><br>• Commercial car washes, including hand washes if the recycled water is not heated, where the general public is excluded from the washing process.<br><br>• Air conditioning system with a tower, evaporative condenser, spraying, or other features that emit vapor or droplets. |

In addition to the standards and criteria listed above in Table A3-5, California limits the use of disinfected tertiary recycled within 50-feet of any domestic water supply unless specific criteria outlined in the California Health Laws Related to Recycled Water are met. There shall be no direct, overspray, or runoff contacting designated outdoor eating areas, food handing facilities, or drinking fountains. For impoundments with disinfected tertiary water, there must be a minimum distance of 100-feet from any domestic water supply well.

### A3.2.2 California's Disinfected Secondary-2.2 Recycled Water

Similar to the disinfection criteria of total coliforms for disinfected tertiary recycled water standards described above, California requires the same reduction of total coliforms for secondary-2.2 recycled water. Oxidization and disinfection are the required minimum treatment processes for meeting secondary-2.2 standards. Examples of potential reuse include irrigation of food crops where the edible portion is produced above ground and not contacted by the recycled water, and restricted recreational impoundments where recreation is limited to non-body contact activities. Table A3-6 below details the standards and criteria adapted from the California Health Laws Related to Recycled Water (California, 2001) and Title 22 and 17 of California Code of Regulations (California, 2001).

Table A3-6: California's Disinfected Secondary-2.2 Recycled Water Standards and Approved Specific Beneficial Reuses.(Adapted from California Health Laws Related to Recycled Water, 2001 and Titles 22 and 17 of California Code of Regulations, 2001).

| Treatment Standards and Criteria (Oxidized and Disinfected) | Examples of Specific Beneficial Reuses that may Eventually Become Applicable on Guam |
|---|---|
| A. After adequate contact with disinfectant the number of total coliform organisms shall not exceed:<br><br>1.) A median value of 2.2 per 100 milliliters as determined from the bacteriological results of the last seven days for which sample analyses have been completed, and;<br><br>2.) A maximum value of 23 per 100 milliliters in more than one sample in any 30 day period. | • Restricted recreational impoundments, where recreation is limited to fishing, boating and non-body contact water recreational activities. |

In addition to the standards and criteria listed above in Table A3-6, the utilization of disinfected secondary-2.2 water by means of irrigation or an impoundment requires that the outer periphery of the irrigated area is not within 100-feet of any domestic water supply well, or a residence property such as a place where public exposure is likely. Similar to the other categories, when irrigating with disinfected secondary-2.2 recycled water, direct, overspray, and runoff shall not contact designated outdoor eating areas, food handing facilities, or drinking fountains. Several other requirements and monitoring guidelines must be followed when irrigating with disinfected secondary-2.2 water and are outlined in California's Health Laws Related to Recycled Water (California, 2001) and Titles 22 and 17 of California Code of Regulations (California, 2001).

### A3.2.3 California's Disinfected Secondary-23 Recycled Water

California requires oxidization and disinfection treatment processes for meeting secondary-23 standards. Examples for potential reuse include irrigation of restricted areas where public contact is limited and runoff is controlled. Table A3-7 below details the standards and criteria adapted from the California Health Laws Related to Recycled Water (California, 2001) and Title 22 and 17 of California Code of Regulations (California, 2001).

Table A3-7: California's Disinfected Secondary–23 Recycled Water Standards and Approved Specific Beneficial Reuses.(Adapted from California Health Laws Related to Recycled Water, 2001 and Titles 22 and 17 of California Code of Regulations, 2001).

| Treatment Standards and Criteria (Oxidized and Disinfected) | Examples of Specific Beneficial Reuses that may Eventually Become Applicable on Guam |
|---|---|
| A. After adequate contact with disinfectant, the number of total coliform organisms shall not exceed:<br><br>1.) A median value of 23 per 100 milliliters as determined from the bacteriological results of the last seven days for which sample analyses have been completed, and;<br><br>2.) A maximum value of 240 per 100 milliliters in more than one sample in any 30 day period. | • Any form of surface irrigation for cemeteries, freeway landscaping, restricted access golf courses, ornamental nursery stock and sod farm where access by the general public is not restricted, pasture for animals producing milk for human consumption, and any non-edible vegetation where access is controlled so that irrigated areas can not be used as if it were part of a park, playground, or schoolyard.<br><br>• Non-structural firefighting<br><br>• Soil Compaction |

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|---|---|
| | • Mixing Concrete<br>• Dust control on roads and streets<br>• Cleaning roads, sidewalks, and outdoor work areas<br>• Industrial process water that will not come into contact with workers<br>• Air conditioning system without tower, evaporative condenser, spraying, or other features that emit vapor or droplets. |

In addition to the standards and criteria listed above in Table A3-7, the utilization of disinfected secondary-23 recycled water by means of irrigation or an impoundment requires that the outer periphery of the application area is not within 100-feet of any domestic water supply well, or a residence property such as a place where public exposure is likely. Similar to the other reuse categories, when irrigating with disinfected secondary-23 recycled water, direct, overspray, and runoff shall not contact designated outdoor eating areas, food handing facilities or drinking fountains. Several other requirements and monitoring guidelines must be followed when irrigating with disinfected secondary-23 recycled water and are outlined in California's Health Laws Related to Recycled Water (California, 2001) and Titles 22 and 17 of California Code of Regulations (California, 2001).

### A3.2.4 California's Undisinfected Secondary Recycled Water

California requires oxidization as a form of secondary treatment for meeting the undisinfected secondary recycled water standards. The examples of potential reuse options are limited for this category, but can include surface irrigation where the recycled water does not come into contact with the edible portion of the crop, and where the general public has restricted access to the irrigated areas. Table A3-8 below details the standards and criteria adapted from the California Health Laws Related to Recycled Water (California, 2001) and Title 22 and 17 of California Code of Regulations (California, 2001).

Table A3-8: California's Undisinfected Secondary Water Standards and Approved Specific Beneficial Reuses. (Adapted from California Health Laws Related to Recycled Water, 2001 and Titles 22 and 17 of California Code of Regulations, 2001).

| Treatment Standards and Criteria (Oxidized) | Examples of Specific Beneficial Reuses that may Eventually Become Applicable on Guam |
|---|---|
| A. Must meet California's standards associated with Undisinfected Secondary Treatment. | • Surface irrigation for orchards where recycled water does not come into contact with the edible portion of the crop, vineyards where the recycled water does not come in contact with the edible portion of the crop, non food bearing trees (Christmas tree farms are included in this category provided no irrigation with recycled water occurs for a period of 14 days prior to harvesting or allowing access by the general public, fodder and fiber crop and pasture for animals not producing milk for human consumption, or seed crop not eaten by humans.<br>• Food crops that must undergo commercial pathogen |

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| | destroying processing before being consumed by humans.<br><br>• Ornamental nursery stock and sod farms provided no irrigation with recycled water occurs for a period of 14 days prior to harvesting, retail sale, or allowing access by the general public. |

Similar to the other categories, when irrigating with undisinfected secondary water, the direct overspray, and runoff shall not contact designated outdoor eating areas, food handing facilities or drinking fountains, and can not be applied within 100-feet of a residence or a place where public exposure is likely. Additionally, California requires a minimum of 150 feet of any domestic water supply.

Unlike Hawaii, California does not have a single standard BOD5 or TSS maximum concentration for STP effluent. These maximum concentrations are established for each STP on a case-by-case basis, such that the specific outfall or beneficial use of the treated effluent governs the BOD5 and TSS maximum concentrations. The EPA suggested maximum concentration for BOD5 and TSS is 30 mg/L, similar to Hawaii, however many WWTPs in California require much lower concentrations closer to 10 mg/L and even 5 mg/L. In addition to the BOD5 and TSS concentrations, the tables presented above do not detail additional requirements and criteria associated with the various beneficial reuse options. Some of these additional requirements include irrigation application plans, labeling and signage, employee training, vector control, monitoring, record keeping and public information. Furthermore, reliability requirements for wastewater treatment plants generating recycled water for beneficial uses include alarm systems, in addition to auxiliary treatment and power systems. These additional requirements are listed in California Health Laws Related to Recycled Water (California, 2001), and Title 22 and 17 of California Code of Regulations (California, 2001).

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