# APPENDICES

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2001 MIXING ZONE ANALYSIS

In accordance with applicable WQS, mixing zones may only be established if necessary to ensure the continued operation of the Sadog Tasi WWTP, which is in the public interest, and if mixing zones for the Sadog Tasi WWTP discharge will not substantially endanger public health and safety.

According to the 2001 mixing zone analysis, using Visual Plumes--a dilution model which may be applied to ocean discharges, USEPA Region 9 had evaluated discharge-induced mixing for the Saipan Lagoon Outfall with the assistance of Dr. Walter Frick (USEPA National Exposure Research Laboratory/ORD, Athens, GA). Inputs to Visual Plumes for the Sadog Tasi outfall and diffuser system were summarized below:

1. Port diameter: 6 inches. (From AS-BUILT drawing: *Sewer outfall (off-shore) detail trench area and diffuser assembly*, DWG. NO. SH-0S-004, SHT. NO. 4/4.)

2. Number of ports: 6. The last three ports and the end of the diffuser are closed with a blind flange. (From AS-BUILT drawing: *Sewer outfall (off-shore) detail trench area and diffuser assembly*, DWG. NO. SH-0S-004, SHT. NO. 4/4.) Both 6 ports and 3 ports open were modeled.

3. Port spacing: 19.68 feet. (From AS-BUILT drawing: *Sewer outfall (off-shore) detail trench area and diffuser assembly*, DWG. NO. SH-0S-004, SHT. NO. 4/4.)

4. Vertical angle: 90 degrees. (From AS-BUILT drawing: *Sewer outfall (off-shore) detail trench area and diffuser assembly*, DWG. NO. SH-0S-004, SHT. NO. 4/4.)

5. Bell or sharp edge port: Bell edge. (From AS-BUILT drawing: *Sewer outfall (off-shore) detail trench area and diffuser assembly*, DWG. NO. SH-0S-004, SHT. NO. 4/4.)

6. Port depth: 49 feet below sea level. (From 1995 NPDES application, Standard Form A.)

7. Effluent flow: -4.8 MGD (average daily design). (From Mike Lee in fact sheet for 08/12/99 draft permit.) Both effluent flows values were modeled.

8. Effluent salinity: 4.5 parts per thousand.

9. Effluent temperature: 30 degrees Celsius.

10. Current speed: 0 meters/second. This is a conservative assumption. The following represents a range of currents measured in the vicinity of the outfall: 15 -24 centimeters/second.

11. Background concentration: 0.

12. The CUC has indicated that the effluent plume surfaces most of the time. This is based on fecal coliform data collected at the surface above the outfall diffuser. The conservative initial dilution is based on an assumption that the receiving water is not stratified in the vicinity of the Saipan Lagoon Outfall.

Based on these inputs, US EPA Region 9 had calculated several initial dilution ratios and determined a conservative initial dilution of 77 parts seawater to 1 part wastewater (i.e., 77:1) for the Saipan Lagoon Outfall to be appropriate, as follows:

| Effluent Flow (in MGD)/# of Ports | Initial Dilution Ratio | y-position from outfall diffuser |
|---|---|---|
| 3.0 / 6 | 102 : 1 | 16. 9 ft; surface |
| 3.0 / 3 | 82 : 1 | 26.53 ft; surface |
| 4.8 / 6 | 87 : 1 | 24.81 ft; surface |
| **4.8 / 3** | ***77 : 1*** | **41.79 ft; surface** |

APPENDIX B – WATER QUALITY-BASED EFFLUENT LIMITS CALCULATIONS FOR NUTRIENTS AND METALS

| Cb = background seawater concn = 0<br>Dc = critical initial dilution value = 77 | Nitrate-Nitrogen<br>(Cr = 0.5 mg/l) | Total Nitrogen<br>(Cr = 0.75 mg/l) | Orthophosphate<br>(Cr = 0.05 mg/l) | Total Phosphorous<br>(Cr = 0.05 mg/l) | Un-ionized Ammonia<br>(Cr = 0.02 mg/l) |
|---|---|---|---|---|---|
| Ce = Cr + Dc(Cr-Cb) | 0.5 + 77(0.5-0) = 39 | 0.75 + 77(0.75-0) = 58.5 | 0.05 + 77(0.05-0) = 3.9 | 0.05 + 77(0.05-0) = 3.9 | 0.02 + 77 (0.02-0) = 1.56 |
| Acute LTA = WLA x 0.321 | 39 x 0.321 = 12.519 | 58.5 x 0.321 = 18.78 | 3.9 x 0.321 = 1.252 | 3.9 x 0.321 = 1.252 | 1.56 x 0.321 = 0.501 |
| Chronic LTA = WLA x 0.527 | 39 x 0.527 = 20.553 | 58.5 x 0.527 = 31.830 | 3.9 x 0.527 = 2.055 | 3.9 x 0.527 = 2.055 | 1.56 x 0.527 = 0.822 |
| Minimum LTA = lowest value | 12.519 | 18.78 | 1.252 | 1.252 | 0.501 |
| Max daily WQBEL = min LTA x 3.11 | 12.519 x 3.11= 38.9 | 18.78 x 3.11 = 58.4 | 1.252 x 3.11 = 3.9 | 1.252 x 3.11 = 3.9 | 0.501 x 3.11 = 1.6 |
| Avg WQBEL = min LTA x 1.55 | 12.519 x 1.55 = 19.5 | 18.78 x 1.55 = 29.1 | 1.252 x 1.55 = 2.0 | 1.252 x 1.55 = 2.0 | 0.501 x 1.55 = 0.8 |

| | Copper<br>(Acute Cr = 4.8 µg/l )<br>(Chronic Cr = 3.1µg/l)<br>(Human Cr = 1,300 µg/l l) | Silver<br>(Acute Cr = 1.9 µg/l)<br>(Chronic Cr = n/a)<br>(Human Cr = n/a) | Zinc<br>(Acute Cr = 90 µg/l)<br>(Chronic Cr = 81 µg/l)<br>(Human Cr = 26,000 µg/l) |
|---|---|---|---|
| Acute Ce = Acute Cr + Dc(Cr-Cb) | 4.8 + 77 (4.8-0) = 374.4 | 1.9 + 77 (1.9-0) = 148.2 | 90 + 77 (90-0) = 7,020 |
| Chronic Ce = Chronic Cr + Dc(Cr-Cb) | 3.1 + 77 (3.1-0) = 241.8 | -- | 81 + 77 (81-0) = 6,310 |
| Human Ce = Human Cr + Dc (Cr - Cb) | 1,300 + 77 (1,300-0) = 101,400 | -- | 26,000 + 77 (26,000-0) = 2,028,000 |
| Acute LTA = Acute WLA x 0.321 | 374.4 x 0.321 = 120.18 | 148.2 x 0.321 = 45.57 | 7020 x 0.321 = 2,253.42 |
| Chronic LTA = Chronic WLA x 0.527 | 241.8 x 0.527 = 127.43 | 148.2 x 0.527 = 78.10 | 6310 x 0.321 = 3,327.37 |
| Human LTA = Human WTA | 101,400 | -- | 2,028,000 |
| Minimum LTA = lowest value of acute, chronic or human health LTA | 120.18 | 45.57 | 2,253.42 |
| *Max daily WQBEL = min LTA x 3.11 | 120.18 x 3.11 = 373.76 µg/l = 0.38 mg/l | 45.57 x 3.11 = 141.72 µg/l = 0.14 mg/l | 2,253.42 x 3.11= 7,008 µg/l = 7.0 mg/l |
| *Avg monthly WQBEL = min LTA x 1.55 | 120.18 x 1.55 = 186.28 µg/l = 0.19 mg/l | 45.57 x 1.55 = 70.63 µg/l = 0.071 mg/l | 2,253.42 x 1.55= 3,493 µg/l = 3.5 mg/l |
| If min LTA is human health LTA, then avg monthly WQBEL = min LTA | n/a | n/a | n/a |
| Max WQBEL = avg monthly WQBEL x 2.01 | n/a | n/a | n/a |

*Note the conversion from µg/l to mg/l: 1000 µg/l = 1 mg/l