# Appendix G-6
# SONIR Model Results, Alternative 4

NP&V
NELSON POPE & VOORHIS, LLC
ENVIRONMENTAL • PLANNING • CONSULTING

# SIMULATION OF NITROGEN IN RECHARGE (SONIR)

NELSON, POPE & VOORHIS, LLC MICROCOMPUTER MODEL

NAME OF PROJECT

**The Hills at Southampton**

**Alternative 4 - Reduced Density**

### DATA INPUT FIELD

| A | Site Recharge Parameters | Value | Units |
|---|---|---|---|
| 1 | Area of Site | 591.00 | acres |
| 2 | Precipitation Rate | 49.90 | inches |
| 3 | Acreage of Rough/Res/Golf Landsc. | 46.53 | acres |
| 4 | Fraction of Land in above | 0.079 | fraction |
| 5 | Evapotranspiration from above | 23.00 | inches |
| 6 | Runoff from above | 0.35 | inches |
| 7 | Acreage of Greens/Tees/Fairways | 42.00 | acres |
| 8 | Fraction of above | 0.071 | fraction |
| 9 | Evapotranspiration from above | 23.90 | inches |
| 10 | Runoff from above | 0.35 | inches |
| 11 | Acreage of Unvegetated/Dirt Roads | 3.45 | acres |
| 12 | Fraction of above | 0.006 | fraction |
| 13 | Evapotranspiration from above | 21.20 | inches |
| 14 | Runoff from above | 1.05 | inches |
| 15 | Acreage of Water/Ponds/Wetlands | 5.67 | acres |
| 16 | Fraction of Site in above | 0.010 | fraction |
| 17 | Evaporation from above | 30.00 | inches |
| 18 | Makeup Water (if applicable) | 0.00 | inches |
| 19 | Acreage of Natural/Natural Reveg | 469.68 | acres |
| 20 | Fraction of above | 0.795 | fraction |
| 21 | Evapotranspiration from above | 23.00 | inches |
| 22 | Runoff from above | 0.35 | inches |
| 23 | Acreage of Impervious/Paved/Bldgs | 22.27 | acres |
| 24 | Fraction of Land in above | 0.038 | fraction |
| 25 | Evapotrans. from above | 4.99 | inches |
| 26 | Runoff from Impervious | 0.00 | inches |
| 23 | Acreage of Other (Rain Gardens) | 1.40 | acres |
| 24 | Fraction of Land in above | 0.061 | fraction |
| 25 | Evapotrans. from above | 30.00 | inches |
| 26 | Runoff from above | 0.00 | inches |
| 27 | Acreage of Land Irrigated | 46.53 | acres |
| 28 | Fraction of Land Irrigated | 0.079 | fraction |
| 29 | Irrigation Rate | 24.00 | inches |
| 30 | Number of Dwellings | 94 | units |
| 31 | Water Use per Dwelling | 300 | gal/day |
| 32 | Wastewater Design Flow (units) | 6,414 | gal/day |
| 33 | Wastewater Design Flow (total) | 34,614 | gal/day |
| 34 | Adjusted WW Design Flow (total) | 34,614 | gal/day |

| B | Nitrogen Budget Parameters | Value | Units |
|---|---|---|---|
| 1 | Persons per Dwelling | 2.50 | persons |
| 2 | Nitrogen per Person per Year | 10.0 | lbs |
| 3 | a. Sanitary Nitrogen Leaching Rate | 50% | percent |
| 3 | b. Treated Sanitary Nitrogen Leaching Rate | 90% | percent |
| 4 | Fertilized Land (Golf Rough/Res/Golf Landsc.) | 46.53 | acres |
| 5 | Fertilizer Application Rate (for above) | 1.00 | lbs/1000 sq ft |
| 6 | Fertilizer Nitrogen Leaching Rate (for above) | 10% | percent |
| 7 | Fertilized Land (Greens/Tees/Fairways) | 42.00 | acres |
| 8 | Fertilizer Application Rate (for above) | 2.50 | lbs/1000 sq ft |
| 9 | Fertilizer Nitrogen Leaching Rate (for above) | 10% | percent |
| 10 | Pet Waste Application Rate | 3.19 | lbs/pet |
| 11 | Pet Waste Nitrogen Leaching Rate | 50% | percent |
| 12 | Area of Land Irrigated | 46.53 | acres |
| 13 | Irrigation Rate | 24.00 | inches |
| 14 | Irrigation Nitrogen Leaching Rate | 10% | percent |
| 15 | Nitrogen in Precipitation | 0.75 | mg/l |
| 16 | Precipitation Nitrogen Leaching Rate | 15% | percent |
| 17 | Nitrogen in Water Supply | 2.00 | mg/l |
| 18 | Nitrogen in Sanitary Flow -1 | 50.00 | mg/l |
| 19 | Nitrogen in Sanitary Flow -2 | 19.00 | mg/l |

| C | Comments |
|---|---|
| 1) | Please refer to SONIR User Manual for data input instructions. |

| | | |
|---|---|---|
| Developed Area | 116.47 | 20% |
| Natural/Unvegetated/Revegetated Area | 474.53 | 80% |
| Total Acreage Check | 591.00 | 100% |

NELSON, POPE & VOORHIS, LLC MICROCOMPUTER MODEL

**Alternative 4 - Reduced Density**

## SITE RECHARGE COMPUTATIONS

| A | Landscaping | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Land in Cover Type | 0.079 | fraction |
| 2 | P = Precipitation Rate | 49.90 | inches |
| 3 | E = Evapotranspiration Rate | 23.00 | inches |
| 4 | Q = Runoff Rate | 0.35 | inches |
| 5 | R(a) = P - (E + Q) | 26.55 | inches |
| 6 | R(A) = R(a) x A | 2.09 | inches |

| B | Unfertilized Landscape | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Land in Cover Type | 0.071 | fraction |
| 2 | P = Precipitation Rate | 49.90 | inches |
| 3 | E = Evapotranspiration Rate | 23.90 | inches |
| 4 | Q = Runoff Rate | 0.35 | inches |
| 5 | R(b) = P - (E + Q) | 25.65 | inches |
| 6 | R(B) = R(b) x A | 1.82 | inches |

| C | Unvegetated/Dirt Roads | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Land in Cover Type | 0.006 | fraction |
| 2 | P = Precipitation Rate | 49.90 | inches |
| 3 | E = Evapotranspiration Rate | 21.20 | inches |
| 4 | Q = Runoff Rate | 1.05 | inches |
| 5 | R(c) = P - (E + Q) | 27.65 | inches |
| 6 | R(C) = R(c) x A | 0.16 | inches |

| D | Water/Ponds | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Site in Water | 0.010 | fraction |
| 2 | P = Precipitation Rate | 49.90 | inches |
| 3 | E = Evaporation Rate | 30.00 | inches |
| 4 | Q = Runoff Rate | 0.00 | inches |
| 5 | M = Makeup Water | 0.00 | inches |
| 6 | R(d) = {P - (E+Q)} - M | 19.90 | inches |
| 7 | R(D) = R(d) x A | 0.19 | inches |

| E | Natural/Natural Revegetation | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Land in Cover Type | 0.795 | fraction |
| 2 | P = Precipitation Rate | 49.90 | inches |
| 3 | E = Evapotranspiration Rate | 23.00 | inches |
| 4 | Q = Runoff Rate | 0.35 | inches |
| 5 | R(e) = P - (E + Q) | 26.55 | inches |
| 6 | R(E) = R(e) x A | 21.10 | inches |

| F | Impervious/Paved/Roads | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Land in Cover Type | 0.038 | fraction |
| 2 | P = Precipitation Rate | 49.90 | inches |
| 3 | E = Evapotranspiration Rate | 4.99 | inches |
| 4 | Q = Runoff Rate | 0.00 | inches |
| 5 | R(f) = P - (E + Q) | 44.91 | inches |
| 6 | R(F) = R(f) x A | 1.69 | inches |

| F | Rain Gardens/Wetlands | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Land in Cover Type | 0.061 | fraction |
| 2 | P = Precipitation Rate | 49.90 | inches |
| 3 | E = Evapotranspiration Rate | 30.00 | inches |
| 4 | Q = Runoff Rate | 0.00 | inches |
| 5 | R(g) = P - (E + Q) | 19.90 | inches |
| 6 | R(G) = R(g) x A | 1.21 | inches |

| H | Irrigation Recharge | Value | Units |
|---|---|---|---|
| 1 | A = Fraction of Land Irrigated | 0.079 | fraction |
| 2 | I = Irrigation Rate | 24.00 | inches |
| 3 | E = Evaptranspiration Rate | 20.54 | inches |
| 4 | Q = Runoff Rate | 0.35 | inches |
| 5 | R(h) = I - (E + Q) | 3.11 | inches |
| 6 | R(H) = R(H) x A | 0.24 | inches |

| I | Wastewater Recharge | Value | Units |
|---|---|---|---|
| 1 | WDF = Wastewater Design Flow | 34,614 | gal/day |
| 2 | WDF = Wastewater Design Flow | 1,689,181 | cu ft/yr |
| 3 | A = Area of Site | 25,743,960 | sq ft |
| 4 | R(j) = WDF/A | 0.07 | feet |
| 5 | R(I) = Wastewater Recharge | 0.79 | inches |

| J | Runoff Recharge | Value | Units |
|---|---|---|---|
| 1 | Q(A) = Runoff from Rough/Landscaped | 0.028 | inches |
| 2 | Q(B) = Runoff from Tees/Fairways | 0.025 | inches |
| 3 | Q(C) = Runoff from Unvegetated | 0.006 | inches |
| 4 | Q(E) = Runoff from Natural | 0.278 | inches |
| 5 | Q(H) = Runoff from Rain Gardens | 0.000 | inches |
| 6 | Q(I) = Runoff from Irrigation | 0.03 | inches |
| 7 | Q(tot) = Q(A)+Q(B)+Q(C)+Q(E)+Q(H)+Q(I) | 0.36 | inches |

| Total Site Recharge | | |
|---|---|---|
| R(T) = | R(A)+R(B)+R(C)+R(D)+R(E)+R(F)+R(G)+R(H)+R(I)+R(J)+Q(tot) | |
| R(T) = | 29.67 | inches |

NELSON, POPE & VOORHIS, LLC MICROCOMPUTER MODEL

**Alternative 4 - Reduced Density**

## SITE NITROGEN BUDGET

| A | Sanitary Nitrogen-Residential | Value | Units |
|---|---|---|---|
| 1 | Number of Dwellings | 0 | units |
| 2 | Persons per Dwelling | 2.50 | capita |
| 3 | P = Population | 0.00 | capita |
| 4 | N = Nitrogen per person | 10 | lbs |
| 6 | N = (total; pre loss/removal) | 0 | lbs |
| 7 | LR = Leaching Rate | 50% | percent |
| 8 | N(S) = P x N x LR | 0.00 | lbs |
| 9 | N = loss/removed | 0.00 | lbs |

| B | Pet Waste Nitrogen | Value | Units |
|---|---|---|---|
| 1 | AR = Application Rate | 3.19 | lbs/pet |
| 2 | Human Population | 39 | capita |
| 3 | Pets = 17 percent of capita | 7 | pets |
| 4 | N(p) = AR x pets | 21.24 | lbs |
| 5 | LR = Leaching Rate | 50% | percent |
| 6 | N(P) = N(p) x LR | 10.62 | lbs |
| 7 | N = (loss/removed) | 10.62 | lbs |

| C | Sanitary Nitrogen (Wastewater Design Flow) | | |
|---|---|---|---|
| 1 | CF = Commercial/STP Flow | 34,614 | gal/day |
| 2 | CF = Commercial/STP Flow | 47,820,106 | liters/yr |
| 3 | N = Nitrogen (1) | 50.00 | mg/l |
| 4 | N = Nitrogen (1) | 5272.17 | lbs |
| 5 | N =Nitrogen (2) | 50.00 | mg/l |
| 6 | N = Nitrogen (2) | 5272.17 | lbs |
| 7 | LR = Leaching Rate | 50% | percent |
| 8 | N(S) = CF x N x LR | 1,195,502,659 | milligrams |
| 9 | N(S) = Sanitary Nitrogen | 2636.08 | lbs |
| 10 | N = loss/removed | 2636.08 | lbs |

| D | Water Supply Nitrogen (other than wastewater, if applicable) | | |
|---|---|---|---|
| 1 | WDF = Wastewater Design Flow | 0 | gal/day |
| 2 | WDF = Wastewater Design Flow | 0 | liters/yr |
| 3 | N = Nitrogen in Water Supply | 2.00 | mg/l |
| 4 | N(WW) = WDF x N | 0 | milligrams |
| 5 | N(WW) = Wastewater Nitrogen | 0.00 | lbs |

| E | Fertilized Landscaping | | |
|---|---|---|---|
| 1 | A = Area of Land Fertilized 1 | 2,026,847 | sq ft |
| 2 | AR = Application Rate | 1.00 | lbs/1000 sf |
| 3 | N(T) = Nitrogen (total applied) | 2026.85 | lbs |
| 4 | LR = Leaching Rate | 10% | percent |
| 5 | N(F1) = A x AR x LR | 202.68 | lbs |
| 6 | N = loss/removed | 1824.16 | lbs |

| F | Unfertilized Landscape | | |
|---|---|---|---|
| 1 | A = Area of Land Fertilized 2 | 1,829,520 | sq ft |
| 2 | AR = Application Rate | 2.50 | lbs/1000 sf |
| 3 | N(T) = Nitrogen (total applied) | 4573.80 | lbs |
| 4 | LR = Leaching Rate | 10% | percent |
| 5 | N(F2) = A x AR x LR | 457.38 | lbs |
| 6 | N = loss/removed | 4116.42 | lbs |

| G | Precipitation Nitrogen (existing condition) | | |
|---|---|---|---|
| 1 | R(n) = Natural Recharge (feet) | 1.92 | feet |
| 2 | A = Area of Site (sq ft) | 25,743,960 | sq ft |
| 3 | R(N) = R(n) x A | 49,422,921 | cu ft |
| 4 | R(N) = Natural Recharge (liters) | 1,399,657,119 | liters |
| 5 | N = Nitrogen in Precipitation | 0.75 | mg/l |
| 6 | N(T) = Nitrogen (total) | 2,315 | lbs |
| 7 | LR = Leaching Rate | 15% | percent |
| 8 | N(ppt) = R(N) x N x LR | 157,461,425.89 | milligrams |
| 10 | N(irr) = Irrigation Nitrogen | 347.20 | lbs |
| 9 | N = loss/removed | 1967.48 | lbs |

| H | Irrigation Nitrogen | | |
|---|---|---|---|
| 1 | R = Irrigation Recharge (inches) | 0.24 | inches |
| 2 | R = Irrigation Rate (feet) | 0.02 | feet |
| 3 | A = Area of Land Irrigated | 2,026,847 | sq ft |
| 4 | R(I) = R(irr) x A | 0 | cu ft |
| 5 | R(I) = Site Precipitation (liters) | 0 | liters |
| 6 | N = Nitrogen in Water Supply | 2.00 | mg/l |
| 7 | N(T) = Nitrogen (total applied) | 0.00 | lbs |
| 8 | LR = Leaching Rate | 10% | percent |
| 9 | N(irr) = R(I) x N x LR | 0 | milligrams |
| 10 | N(irr) = Irrigation Nitrogen | 0.00 | lbs |
| 11 | N = loss/removed | 0.00 | lbs |

| Total Site Nitrogen | |
|---|---|
| N= | N(S) + N(P) + N(WW) + N(F1) + N(F2) + N(ppt) + N(irr) |
| N= | 3,653.97    lbs |

NP&V

NAME OF PROJECT

**The Hills at Southampton**
**Alternative 4 - Reduced Density**

**FINAL COMPUTATIONS**

| A | Nitrogen in Recharge | Value | Units |
|---|---|---|---|
| 1 | N = Total Nitrogen (lbs) | 3,653.97 | lbs |
| 2 | N = Total Nitrogen (milligrams) | 1,658,902,620 | milligrams |
| 3 | R(T) = Total Recharge (inches) | 29.67 | inches |
| 4 | R(T) = Total Recharge (feet) | 2.47 | feet |
| 5 | A = Area of Site | 25,743,960 | sq ft |
| 6 | R = R(T) x A | 63,642,091 | cu ft |
| 7 | R = Site Recharge Volume | 1,802,344,005 | liters |
| 9 | NR = N/R | 0.92 | mg/l |

CONCENTRATION OF
NITROGEN IN RECHARGE                0.92

| B | Site Recharge Summary | Value | Units |
|---|---|---|---|
| 1 | R(T) = Total Site Recharge | 29.67 | inches/yr |
| 2 | R = Site Recharge Volume | 63,642,091 | cu ft/yr |
| 3 | R = Site Recharge Volume | 476,075,931 | gal/yr |
| 4 | R = Site Recharge Volume | 476.08 | MG/yr |

| Conversions used in SONIR |
|---|
| Acres x 43,560 = Square Feet |
| Cubic Feet x 7.48052 = Gallons |
| Cubic Feet x 28.32 = Liters |
| Days x 365 = Years |
| Feet x 12 = Inches |
| Gallons x 0.1337 = Cubic Feet |
| Gallons x 3.785 = Liters |
| Grams / 1,000 = Milligrams |
| Grams x 0.002205 = Pounds |
| Milligrams / 1,000 = Grams |