



**CREH**

CENTRE FOR  
RESEARCH INTO  
ENVIRONMENT AND  
HEALTH

**Nutrient flux source  
apportionment for  
St Aubin's Bay, Jersey, 2007**

A Report to  
Transport and Technical Services,  
States of Jersey



**January 2008**

**Tables**



**Table 2.1 Sampling and discharge gauging site details**

| Site                                   | Name                                        | Easting<br>(m) | Northing<br>(m) |
|----------------------------------------|---------------------------------------------|----------------|-----------------|
| <b>Water quality monitoring sites:</b> |                                             |                |                 |
| 101                                    | St Brelade's stream at St Aubin's Harbour   | 560575         | 5448825         |
| 102                                    | La Haule A at coastal outfall               | 560850         | 5449375         |
| 103                                    | La Haule B at coastal outfall               | 561300         | 5449675         |
| 104                                    | St Peter's Valley at coastal outfall        | 561650         | 5449825         |
| 105                                    | Waterworks Valley at coastal outfall        | 562950         | 5449775         |
| 106                                    | Bellozanne Valley at sewage treatment works | 563950         | 5450550         |
| 107                                    | Weighbridge outfall at manhole 9            | 565100         | 5448225         |
| 108                                    | Vallée des Vaux at supermarket              | 565575         | 5449750         |
| 109                                    | Grands Vaux below reservoir dam             | 566450         | 5450675         |
| 301                                    | Bellozanne Outfall                          | 563375         | 5449275         |
| 301a                                   | First Tower pumping station manhole         | 563600         | 5449625         |
| <b>Discharge gauging sites:</b>        |                                             |                |                 |
| 101a                                   | St Brelade's stream upstream of culvert     | 560175         | 5448900         |
| 104a                                   | St Peter's Valley at Sandybrook             | 561600         | 5450475         |
| 108                                    | Vallée des Vaux at supermarket              | 565575         | 5449750         |
| 109                                    | Grands Vaux below reservoir dam             | 566450         | 5450675         |

**Table 3.1 Summary of hydrological monitoring results**

| Site                               | $n^a$ | Mean   | S. D. <sup>b</sup> | Minimum | Maximum |
|------------------------------------|-------|--------|--------------------|---------|---------|
| <b>Stage (m)</b>                   |       |        |                    |         |         |
| St Brelade's stream                | 19    | 0.132  | 0.052              | 0.070   | 0.245   |
| St Peter's Valley                  | 21    | 0.204  | 0.069              | 0.120   | 0.330   |
| Vallée des Vaux                    | 23    | 0.133  | 0.074              | 0.035   | 0.310   |
| Grands Vaux <sup>c</sup>           | 7     | 0.167  | 0.076              | 0.070   | 0.270   |
| Grands Vaux <sup>d</sup>           | 3     | 0.173  | 0.115              | 0.060   | 0.290   |
| <b>Discharge (m<sup>3</sup>/s)</b> |       |        |                    |         |         |
| St Brelade's stream                | 19    | 0.0583 | 0.0512             | 0.0080  | 0.1750  |
| St Peter's Valley                  | 21    | 0.1267 | 0.1274             | 0.0140  | 0.4100  |
| Vallée des Vaux                    | 23    | 0.0601 | 0.0392             | 0.0140  | 0.1390  |
| Grands Vaux <sup>c</sup>           | 7     | 0.3073 | 0.1270             | 0.1640  | 0.4880  |
| Grands Vaux <sup>d</sup>           | 3     | 0.1715 | 0.1164             | 0.0790  | 0.3020  |

a  $n$  = number of observations

b Standard deviation

c 21<sup>st</sup> February to 16<sup>th</sup> April 2007

d 25<sup>th</sup> June to 23<sup>rd</sup> July 2007

**Table 3.2**      **Drainage basin analysis results**

| <b>Catchment</b>            | <b>Outlet</b>       | <b>Area from<br/>GIS (km<sup>2</sup>)</b> | <b>Previous Area<br/>estimate (km<sup>2</sup>)</b> |
|-----------------------------|---------------------|-------------------------------------------|----------------------------------------------------|
| St Brelade's stream         | 101                 | 4.37                                      | 4.56                                               |
| St Brelade's stream         | 101a gauging site   | 4.25                                      | nd                                                 |
| La Haule A                  | 102                 | 0.38                                      | 0.51                                               |
| La Haule B                  | 103                 | 1.23                                      | 1.53                                               |
| St Peter's Valley           | 104                 | 12.21                                     | 12.97                                              |
| St Peter's Valley           | 104a gauging site   | 11.64                                     | nd                                                 |
| St Peter's Valley           | Reservoir           | 5.30                                      | 5.53                                               |
| Waterworks Valley           | 105                 | 6.37                                      | 6.70                                               |
| Waterworks Valley           | Millbrook Reservoir | 5.83                                      | 6.00                                               |
| Bellozanne Valley           | 106                 | 3.09                                      | nd                                                 |
| Bellozanne Valley           | Coast               | 3.94                                      | 4.14                                               |
| Grands Vaux/Vallée des Vaux | 107                 | 17.75                                     | 18.70                                              |
| Vallée des Vaux             | 108                 | 3.40                                      | nd                                                 |
| Grands Vaux                 | 109                 | 9.47                                      | 9.24                                               |
| Grands Vaux                 | V-notch weir        | 5.97                                      | 6.34                                               |



Table 3.3 Summary of NH<sub>3</sub>-N concentrations (mg/l) and the results of normality tests

| Site Code | Site                | <i>n</i> <sup>a</sup> | Mean   | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S <i>p</i> <sup>c</sup> | S-W <i>p</i> <sup>d</sup> |
|-----------|---------------------|-----------------------|--------|--------------------|---------|---------|----------|---------------------------|---------------------------|
| 101       | St Brelade's Stream | 21                    | 0.068  | 0.120              | 0.020   | 0.430   | 2.9728   | 0.000                     | 0.000                     |
| 102       | La Haule A          | 18                    | 0.047  | 0.059              | 0.030   | 0.280   | 3.9977   | 0.000                     | 0.000                     |
| 103       | La Haule B          | 20                    | 0.070  | 0.104              | 0.020   | 0.430   | 2.7851   | 0.000                     | 0.000                     |
| 104       | St Peter's Valley   | 20                    | 0.032  | 0.007              | 0.020   | 0.060   | 3.1356   | 0.000                     | 0.000                     |
| 105       | Waterworks Valley   | 20                    | 0.047  | 0.060              | 0.030   | 0.300   | 4.3481   | 0.000                     | 0.000                     |
| 106       | Bellozanne Valley   | 20                    | 0.036  | 0.013              | 0.020   | 0.070   | 1.7234   | 0.000                     | 0.000                     |
| 107       | Weighbridge Outfall | 20                    | 0.225  | 0.254              | 0.030   | 0.870   | 1.7960   | 0.004                     | 0.000                     |
| 108       | Vallée des Vaux     | 20                    | 0.032  | 0.005              | 0.030   | 0.050   | 3.4357   | 0.000                     | 0.000                     |
| 109       | Grands Vaux         | 20                    | 0.051  | 0.065              | 0.030   | 0.320   | 4.2370   | 0.000                     | 0.000                     |
| 301       | Bellozanne Outfall  | 20                    | 20.400 | 11.399             | 1.300   | 44.800  | 0.1803   | 0.200*                    | 0.636*                    |

a *n* = number of observations

b Standard deviation

c significance, *p*, of Kolmogorov-Smirnov normality test

d significance, *p*, Shapiro-Wilk normality test

\* significance  $\geq 0.05$  indicates no significant departure from normality (values  $< 0.05$  indicate significant departure from normality)

Table 3.4 Summary of  $\text{NH}_3\text{-N}$  concentrations (mg/l) at surface water stream monitoring sites after  $\log_{10}$  transformation and the results of normality tests

| Site Code | Site                | n <sup>a</sup> | Geo. Mean <sup>b</sup> | S. D. | Minimum | Maximum | Skewness | K-S $p^d$ | S-W $p^e$ |
|-----------|---------------------|----------------|------------------------|-------|---------|---------|----------|-----------|-----------|
| 101       | St Brelade's Stream | 21             | 0.038                  | 0.353 | 0.020   | 0.430   | 2.9039   | 0.000     | 0.000     |
| 102       | La Haule A          | 18             | 0.036                  | 0.244 | 0.030   | 0.280   | 3.3868   | 0.000     | 0.000     |
| 103       | La Haule B          | 20             | 0.042                  | 0.363 | 0.020   | 0.430   | 2.1438   | 0.000     | 0.000     |
| 104       | St Peter's Valley   | 20             | 0.031                  | 0.084 | 0.020   | 0.060   | 1.8443   | 0.000     | 0.000     |
| 105       | Waterworks Valley   | 20             | 0.036                  | 0.232 | 0.030   | 0.300   | 3.6544   | 0.000     | 0.000     |
| 106       | Bellozanne Valley   | 20             | 0.034                  | 0.135 | 0.020   | 0.070   | 1.3037   | 0.000     | 0.000     |
| 107       | Weighbridge Outfall | 20             | 0.128                  | 0.484 | 0.030   | 0.870   | 0.1666   | 0.200*    | 0.136*    |
| 108       | Vallée des Vaux     | 20             | 0.031                  | 0.056 | 0.030   | 0.050   | 3.2956   | 0.000     | 0.000     |
| 109       | Grands Vaux         | 20             | 0.039                  | 0.245 | 0.030   | 0.320   | 3.0659   | 0.000     | 0.000     |

a  $n$  = number of observations

b Geometric mean, calculated as  $10^x$ , where  $x$  is the mean of  $\log_{10}$  transformed values

c Standard deviation of  $\log_{10}$  transformed values

d significance,  $p$ , of Kolmogorov-Smirnov normality test

e significance,  $p$ , Shapiro-Wilk normality test

\* significance  $\geq 0.05$  indicates no significant departure from normality (values  $< 0.05$  indicate significant departure from normality)

Table 3.5 Summary of NO<sub>2</sub>-N concentrations (mg/l) and the results of normality tests

| Site Code | Site                | n <sup>a</sup> | Mean  | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S p <sup>c</sup> | S-W p <sup>d</sup> |
|-----------|---------------------|----------------|-------|--------------------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 21             | 0.019 | 0.013              | 0.005   | 0.052   | 1.4918   | 0.003              | 0.000              |
| 102       | La Haule A          | 18             | 0.022 | 0.017              | 0.005   | 0.072   | 1.7350   | 0.096*             | 0.008              |
| 103       | La Haule B          | 20             | 0.014 | 0.009              | 0.003   | 0.041   | 1.6256   | 0.053*             | 0.006              |
| 104       | St Peter's Valley   | 20             | 0.018 | 0.007              | 0.008   | 0.037   | 1.0051   | 0.061*             | 0.090*             |
| 105       | Waterworks Valley   | 20             | 0.029 | 0.023              | 0.008   | 0.106   | 2.3166   | 0.001              | 0.000              |
| 106       | Bellozanne Valley   | 20             | 0.036 | 0.041              | 0.004   | 0.196   | 3.4361   | 0.000              | 0.000              |
| 107       | Weighbridge Outfall | 20             | 0.038 | 0.020              | 0.014   | 0.089   | 1.0149   | 0.023              | 0.023              |
| 108       | Vallée des Vaux     | 20             | 0.019 | 0.008              | 0.005   | 0.041   | 0.8948   | 0.033              | 0.219*             |
| 109       | Grands Vaux         | 20             | 0.019 | 0.007              | 0.008   | 0.037   | 0.7633   | 0.200*             | 0.471*             |
| 301       | Bellozanne Outfall  | 20             | 0.853 | 0.411              | 0.247   | 1.660   | 0.3406   | 0.200*             | 0.564*             |

a n = number of observations

b Standard deviation

c significance, p, of Kolmogorov-Smirnov normality test

d significance, p, Shapiro-Wilk normality test

\* significance  $\geq 0.05$  indicates no significant departure from normality (values  $< 0.05$  indicate significant departure from normality)

Table 3.6 Summary of NO<sub>2</sub>-N concentrations (mg/l) at surface water stream monitoring sites after log<sub>10</sub> transformation and the results of normality tests

| Site Code | Site                | n <sup>a</sup> | Geo. Mean <sup>b</sup> | S. D. | Minimum | Maximum | Skewness | K-S p <sup>d</sup> | S-W p <sup>e</sup> |
|-----------|---------------------|----------------|------------------------|-------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 21             | 0.016                  | 0.267 | 0.005   | 0.052   | 0.4244   | 0.200*             | 0.221*             |
| 102       | La Haule A          | 18             | 0.017                  | 0.312 | 0.005   | 0.072   | -0.0035  | 0.200*             | 0.985*             |
| 103       | La Haule B          | 20             | 0.011                  | 0.282 | 0.003   | 0.041   | -0.0598  | 0.200*             | 0.909*             |
| 104       | St Peter's Valley   | 20             | 0.016                  | 0.175 | 0.008   | 0.037   | -0.0665  | 0.200*             | 0.533*             |
| 105       | Waterworks Valley   | 20             | 0.023                  | 0.282 | 0.008   | 0.106   | 0.6008   | 0.200*             | 0.687*             |
| 106       | Bellozanne Valley   | 20             | 0.026                  | 0.343 | 0.004   | 0.196   | 0.3012   | 0.092*             | 0.286*             |
| 107       | Weighbridge Outfall | 20             | 0.034                  | 0.219 | 0.014   | 0.089   | 0.2552   | 0.148*             | 0.287*             |
| 108       | Vallée des Vaux     | 20             | 0.018                  | 0.201 | 0.005   | 0.041   | -0.6837  | 0.169*             | 0.326*             |
| 109       | Grands Vaux         | 20             | 0.018                  | 0.162 | 0.008   | 0.037   | -0.2295  | 0.200*             | 0.974*             |

a n = number of observations

b Geometric mean, calculated as  $10^{\bar{x}}$ , where  $\bar{x}$  is the mean of log<sub>10</sub> transformed values

c Standard deviation of log<sub>10</sub> transformed values

d significance, p, of Kolmogorov-Smirnov normality test

e significance, p, Shapiro-Wilk normality test

\* significance  $\geq 0.05$  indicates no significant departure from normality (values  $< 0.05$  indicate significant departure from normality)

Table 3.7 Summary of NO<sub>3</sub>-N concentrations (mg/l) and the results of normality tests

| Site Code | Site                | n <sup>a</sup> | Mean  | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S p <sup>c</sup> | S-W p <sup>d</sup> |
|-----------|---------------------|----------------|-------|--------------------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 21             | 8.48  | 3.42               | 2.10    | 12.80   | -0.3335  | 0.200*             | 0.175*             |
| 102       | La Haule A          | 18             | 8.57  | 3.17               | 2.50    | 13.00   | -0.1211  | 0.200*             | 0.231*             |
| 103       | La Haule B          | 20             | 12.40 | 4.89               | 2.30    | 19.80   | -0.4184  | 0.200*             | 0.565*             |
| 104       | St Peter's Valley   | 20             | 10.59 | 2.86               | 5.40    | 14.60   | -0.3653  | 0.200*             | 0.167*             |
| 105       | Waterworks Valley   | 20             | 7.11  | 2.76               | 3.60    | 11.20   | 0.3141   | 0.200*             | 0.028              |
| 106       | Bellozanne Valley   | 20             | 13.22 | 4.99               | 5.20    | 19.70   | -0.4395  | 0.200*             | 0.057*             |
| 107       | Weighbridge Outfall | 20             | 8.75  | 3.13               | 2.40    | 13.60   | -0.6451  | 0.200*             | 0.151*             |
| 108       | Vallée des Vaux     | 20             | 10.21 | 2.97               | 3.90    | 14.20   | -0.4428  | 0.200*             | 0.154*             |
| 109       | Grands Vaux         | 20             | 9.77  | 2.21               | 5.30    | 13.50   | -0.0135  | 0.200*             | 0.877*             |
| 301       | Bellozanne Outfall  | 20             | 3.51  | 2.09               | 0.80    | 7.80    | 0.1001   | 0.200*             | 0.175*             |

a n = number of observations

b Standard deviation

c significance, p, of Kolmogorov-Smirnov normality test

d significance, p, Shapiro-Wilk normality test

\* significance ≥ 0.05 indicates no significant departure from normality (values < 0.05 indicate significant departure from normality)



**Table 3.8** Summary of multiple comparisons (Tamhane test significance, *p*) between mean NO<sub>3</sub>-N concentrations (mg/l) in stream inputs to St Aubin's Bay

| Site                | Site Code | Mean (mg/l) | 101    | 102    | 103   | 104   | 105    | 106    | 107    |
|---------------------|-----------|-------------|--------|--------|-------|-------|--------|--------|--------|
| St Brelade's Stream | 101       | 8.48        | --     | 1.000  | 0.109 | 0.559 | 0.978  | 0.025* | 1.000  |
| La Haule A          | 102       | 8.57        | 1.000  | --     | 0.133 | 0.649 | 0.959  | 0.032* | 1.000  |
| La Haule B          | 103       | 12.40       | 0.109  | 0.133  | --    | 0.976 | 0.004  | 1.000  | 0.160  |
| St Peter's Valley   | 104       | 10.59       | 0.559  | 0.649  | 0.976 | --    | 0.008  | 0.657  | 0.730  |
| Waterworks Valley   | 105       | 7.11        | 0.978  | 0.959  | 0.004 | 0.008 | --     | 0.001* | 0.852  |
| Bellozanne Valley   | 106       | 13.22       | 0.025* | 0.032* | 1.000 | 0.657 | 0.001* | --     | 0.038* |
| Weighbridge Outfall | 107       | 8.75        | 1.000  | 1.000  | 0.160 | 0.730 | 0.852  | 0.038* | --     |

\* indicates a significant difference between means compared ( $p < 0.05$ )

Table 3.9 Summary of DAIN<sup>a</sup> concentrations (mg/l) and the results of normality tests

| Site Code | Site                | n <sup>b</sup> | Mean  | S. D. <sup>c</sup> | Minimum | Maximum | Skewness | K-S p <sup>d</sup> | S-W p <sup>e</sup> |
|-----------|---------------------|----------------|-------|--------------------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 21             | 8.56  | 3.40               | 2.57    | 13.27   | -0.269   | 0.200*             | 0.231*             |
| 102       | La Haule A          | 18             | 8.64  | 3.14               | 2.59    | 13.04   | -0.104   | 0.200*             | 0.226*             |
| 103       | La Haule B          | 20             | 12.48 | 4.82               | 2.77    | 19.84   | -0.392   | 0.200*             | 0.533*             |
| 104       | St Peter's Valley   | 20             | 10.63 | 2.86               | 5.45    | 14.64   | -0.363   | 0.200*             | 0.165*             |
| 105       | Waterworks Valley   | 20             | 7.18  | 2.77               | 3.65    | 11.25   | 0.297    | 0.200*             | 0.025              |
| 106       | Bellozanne Valley   | 20             | 13.29 | 4.97               | 5.26    | 19.74   | -0.438   | 0.200*             | 0.059*             |
| 107       | Weighbridge Outfall | 20             | 9.01  | 3.08               | 2.84    | 13.66   | -0.736   | 0.200*             | 0.105*             |
| 108       | Vallée des Vaux     | 20             | 10.26 | 2.97               | 3.94    | 14.25   | -0.447   | 0.200*             | 0.157*             |
| 109       | Grands Vaux         | 20             | 9.84  | 2.21               | 5.34    | 13.55   | -0.038   | 0.200*             | 0.876*             |
| 301       | Bellozanne Outfall  | 20             | 24.76 | 11.01              | 4.19    | 46.92   | 0.082    | 0.200*             | 0.944*             |

a DAIN = dissolved available inorganic nitrogen – NH<sub>3</sub>-N + NO<sub>2</sub>-N + NO<sub>3</sub>-N

b n = number of observations

c Standard deviation

d significance, p, of Kolmogorov-Smirnov normality test

e significance, p, Shapiro-Wilk normality test

\* significance ≥ 0.05 indicates no significant departure from normality (values < 0.05 indicate significant departure from normality)

**Table 3.10** Summary of multiple comparisons (Tamhane test significance, *p*) between mean DAIN<sup>a</sup> concentrations (mg/l) in stream inputs to St Aubin's Bay

| Site                | Site Code | Mean (mg/l) | 101    | 102    | 103    | 104    | 105    | 106    | 107   |
|---------------------|-----------|-------------|--------|--------|--------|--------|--------|--------|-------|
| St Brelade's Stream | 101       | 8.56        | --     | 1.000  | 0.102  | 0.584  | 0.976  | 0.025* | 1.000 |
| La Haule A          | 102       | 8.64        | 1.000  | --     | 0.119  | 0.655  | 0.958  | 0.030* | 1.000 |
| La Haule B          | 103       | 12.48       | 0.102  | 0.119  | --     | 0.967  | 0.004* | 1.000  | 0.201 |
| St Peter's Valley   | 104       | 10.63       | 0.584  | 0.655  | 0.967  | --     | 0.009* | 0.637  | 0.870 |
| Waterworks Valley   | 105       | 7.18        | 0.976  | 0.958  | 0.004* | 0.009* | --     | 0.001* | 0.702 |
| Bellozanne Valley   | 106       | 13.29       | 0.025* | 0.030* | 1.000  | 0.637  | 0.001* | --     | 0.053 |
| Weighbridge Outfall | 107       | 9.01        | 1.000  | 1.000  | 0.201  | 0.870  | 0.702  | 0.053  | --    |

a DAIN = dissolved available inorganic nitrogen – NH<sub>3</sub>-N + NO<sub>2</sub>-N + NO<sub>3</sub>-N

\* indicates a significant difference between means compared (*p* < 0.05)

Table 3.11 Summary of PO<sub>4</sub>-P concentrations (mg/l) and the results of normality tests

| Site Code | Site                | n <sup>a</sup> | Mean  | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S p <sup>c</sup> | S-W p <sup>d</sup> |
|-----------|---------------------|----------------|-------|--------------------|---------|---------|----------|--------------------|--------------------|
| 101       | St Breladé's Stream | 21             | 0.167 | 0.289              | 0.070   | 1.400   | 4.2973   | 0.000              | 0.000              |
| 102       | La Haule A          | 18             | 0.143 | 0.068              | 0.090   | 0.350   | 2.0648   | 0.006              | 0.000              |
| 103       | La Haule B          | 20             | 0.168 | 0.095              | 0.100   | 0.430   | 1.5581   | 0.000              | 0.000              |
| 104       | St Peter's Valley   | 20             | 0.261 | 0.420              | 0.100   | 2.020   | 4.2879   | 0.000              | 0.000              |
| 105       | Waterworks Valley   | 20             | 0.154 | 0.286              | 0.030   | 1.360   | 4.3573   | 0.000              | 0.000              |
| 106       | Bellozanne Valley   | 20             | 0.371 | 1.209              | 0.020   | 5.500   | 4.4485   | 0.000              | 0.000              |
| 107       | Weighbridge Outfall | 20             | 0.149 | 0.049              | 0.100   | 0.240   | 0.6893   | 0.061*             | 0.008              |
| 108       | Vallée des Vaux     | 20             | 0.192 | 0.370              | 0.060   | 1.750   | 4.3604   | 0.000              | 0.000              |
| 109       | Grands Vaux         | 20             | 0.186 | 0.127              | 0.080   | 0.650   | 2.7488   | 0.014              | 0.000              |
| 301       | Bellozanne Outfall  | 20             | 2.894 | 1.369              | 1.220   | 5.560   | 0.6313   | 0.200*             | 0.078*             |

a n = number of observations

b Standard deviation

c significance, p, of Kolmogorov-Smirnov normality test

d significance, p, Shapiro-Wilk normality test

\* significance  $\geq 0.05$  indicates no significant departure from normality (values  $< 0.05$  indicate significant departure from normality)

Table 3.12 Summary of PO<sub>4</sub>-P concentrations (mg/l) at surface water stream monitoring sites after log<sub>10</sub> transformation and the results of normality tests

| Site Code | Site                | n <sup>a</sup> | Geo. Mean <sup>b</sup> | S. D. | Minimum | Maximum | Skewness | K-S p <sup>d</sup> | S-W p <sup>e</sup> |
|-----------|---------------------|----------------|------------------------|-------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 21             | 0.111                  | 0.291 | 0.070   | 1.400   | 3.2451   | 0.000              | 0.000              |
| 102       | La Haule A          | 18             | 0.133                  | 0.164 | 0.090   | 0.350   | 1.3825   | 0.086*             | 0.004              |
| 103       | La Haule B          | 20             | 0.149                  | 0.205 | 0.100   | 0.430   | 1.0638   | 0.001              | 0.001              |
| 104       | St Peter's Valley   | 20             | 0.177                  | 0.299 | 0.100   | 2.020   | 2.4525   | 0.031              | 0.000              |
| 105       | Waterworks Valley   | 20             | 0.094                  | 0.340 | 0.030   | 1.360   | 1.9051   | 0.011              | 0.001              |
| 106       | Bellozanne Valley   | 20             | 0.105                  | 0.473 | 0.020   | 5.500   | 2.6015   | 0.000              | 0.000              |
| 107       | Weighbridge Outfall | 20             | 0.141                  | 0.139 | 0.100   | 0.240   | 0.3107   | 0.021              | 0.011              |
| 108       | Vallée des Vaux     | 20             | 0.118                  | 0.316 | 0.060   | 1.750   | 2.9278   | 0.000              | 0.000              |
| 109       | Grands Vaux         | 20             | 0.160                  | 0.226 | 0.080   | 0.650   | 0.9489   | 0.014              | 0.031              |

a n = number of observations

b Geometric mean, calculated as  $10^{\bar{x}}$ , where  $\bar{x}$  is the mean of log<sub>10</sub> transformed values

c Standard deviation of log<sub>10</sub> transformed values

d significance, p, of Kolmogorov-Smirnov normality test

e significance, p, Shapiro-Wilk normality test

\* significance  $\geq 0.05$  indicates no significant departure from normality (values  $< 0.05$  indicate significant departure from normality)



Table 3.13 Mean ranks of  $\text{PO}_4\text{-P}$  concentration data from Kruskal-Wallis tests

| Site Code                                           | Site                | $n^a$ | Mean Rank-<br>all input sites | Mean Rank-<br>stream input<br>sites only |
|-----------------------------------------------------|---------------------|-------|-------------------------------|------------------------------------------|
| <b>Inputs to St Aubin's Bay:</b>                    |                     |       |                               |                                          |
| 101                                                 | St Brelade's Stream | 21    | 46.71                         | 46.62                                    |
| 102                                                 | La Haule A          | 18    | 80.11                         | 80.11                                    |
| 103                                                 | La Haule B          | 20    | 86.93                         | 86.93                                    |
| 104                                                 | St Peter's Valley   | 20    | 95.45                         | 95.08                                    |
| 105                                                 | Waterworks Valley   | 20    | 46.65                         | 46.55                                    |
| 106                                                 | Bellozanne Valley   | 20    | 50.20                         | 49.25                                    |
| 107                                                 | Weighbridge Outfall | 20    | 87.65                         | 87.65                                    |
| 301                                                 | Bellozanne Outfall  | 20    | 147.98                        |                                          |
| <b>Grands Vaux/Vallée des Vaux catchment sites:</b> |                     |       |                               |                                          |
| 107                                                 | Weighbridge Outfall | 20    | 33.98                         |                                          |
| 108                                                 | Vallée des Vaux     | 20    | 21.08                         |                                          |
| 109                                                 | Grands Vaux         | 20    | 36.45                         |                                          |

<sup>a</sup>  $n$  = number of observations

Table 3.14 Summary of nutrient concentrations (mg/l) in crude, primary settled and final effluent from Bellozanne sewage treatment works and the results of normality tests

| Treatment stage                                                                                               | <i>n</i> <sup>a</sup> | Mean  | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S <i>p</i> <sup>c</sup> | S-W <i>p</i> <sup>d</sup> |
|---------------------------------------------------------------------------------------------------------------|-----------------------|-------|--------------------|---------|---------|----------|---------------------------|---------------------------|
| <b>NH<sub>3</sub>-N</b>                                                                                       |                       |       |                    |         |         |          |                           |                           |
| Crude                                                                                                         | 92                    | 40.54 | 15.10              | 13.30   | 90.79   | 0.8354   | 0.178*                    | 0.005                     |
| Primary settled                                                                                               | 92                    | 35.57 | 9.79               | 15.92   | 58.17   | 0.0430   | 0.200*                    | 0.417*                    |
| Final                                                                                                         | 92                    | 23.00 | 10.87              | 0.41    | 42.34   | -0.2072  | 0.035                     | 0.071*                    |
| <b>NO<sub>2</sub>-N</b>                                                                                       |                       |       |                    |         |         |          |                           |                           |
| Crude                                                                                                         | 92                    | 0.13  | 0.34               | 0.01    | 2.01    | 3.4151   | 0.000                     | 0.000                     |
| Primary settled                                                                                               | 92                    | 0.09  | 0.19               | 0.01    | 0.77    | 2.1570   | 0.000                     | 0.000                     |
| Final                                                                                                         | 92                    | 0.72  | 0.37               | 0.16    | 2.14    | 0.9368   | 0.060*                    | 0.001                     |
| <b>NO<sub>3</sub>-N</b>                                                                                       |                       |       |                    |         |         |          |                           |                           |
| Crude                                                                                                         | 92                    | 0.79  | 1.35               | 0.50    | 9.50    | 5.3732   | 0.000                     | 0.000                     |
| Primary settled                                                                                               | 92                    | 0.60  | 0.43               | 0.50    | 3.80    | 5.7456   | 0.000                     | 0.000                     |
| Final                                                                                                         | 92                    | 5.17  | 1.62               | 0.50    | 9.40    | -0.1159  | 0.200*                    | 0.226*                    |
| <b>DAIN – dissolved available inorganic nitrogen (NH<sub>3</sub>-N + NO<sub>2</sub>-N + NO<sub>3</sub>-N)</b> |                       |       |                    |         |         |          |                           |                           |
| Crude                                                                                                         | 92                    | 41.46 | 15.15              | 15.99   | 94.23   | 0.9252   | 0.055*                    | 0.001                     |
| Primary settled                                                                                               | 92                    | 36.26 | 9.53               | 18.70   | 58.68   | 0.1300   | 0.200*                    | 0.239*                    |
| Final                                                                                                         | 92                    | 28.89 | 10.84              | 6.27    | 49.65   | -0.2089  | 0.200*                    | 0.161*                    |
| <b>PO<sub>4</sub>-P</b>                                                                                       |                       |       |                    |         |         |          |                           |                           |
| Crude                                                                                                         | 92                    | 4.85  | 1.53               | 1.00    | 8.50    | 0.0318   | 0.200*                    | 0.925*                    |
| Primary settled                                                                                               | 92                    | 6.75  | 2.40               | 1.70    | 12.10   | -0.2351  | 0.200*                    | 0.164*                    |
| Final                                                                                                         | 92                    | 3.31  | 1.49               | 0.40    | 7.80    | 0.3092   | 0.200*                    | 0.358*                    |

a *n* = number of observations

b Standard deviation

c significance, *p*, of Kolmogorov-Smirnov normality test

d significance, *p*, Shapiro-Wilk normality test

\* significance ≥ 0.05 indicates no significant departure from normality (values < 0.05 indicate significant departure from normality)

**Table 3.15** Summary Student's t tests to compare mean concentrations of nutrients in the final effluent from Bellozanne sewage treatment works and the outfall (site 301)

| Parameter          | Mean in Final effluent (mg/l) | Mean at outfall (mg/l) | Levene statistic <sup>a</sup> | Levene test $p^b$ | Equal variances assumed? | t statistic <sup>c</sup> | D.F. <sup>d</sup> | t test $p^e$ |
|--------------------|-------------------------------|------------------------|-------------------------------|-------------------|--------------------------|--------------------------|-------------------|--------------|
| NH <sub>3</sub> -N | 23.00                         | 20.40                  | 0.003                         | 0.956             | Yes                      | 0.960                    | 110.0             | 0.339        |
| NO <sub>2</sub> -N | 0.72                          | 0.85                   | 0.940                         | 0.334             | Yes                      | -1.395                   | 110.0             | 0.166        |
| NO <sub>3</sub> -N | 5.17                          | 3.51                   | 4.980                         | 0.027*            | No                       | 3.357                    | 24.2              | 0.003*       |
| DAIN               | 28.89                         | 24.76                  | 0.058                         | 0.810             | Yes                      | 1.542                    | 110               | 0.126        |
| PO <sub>4</sub> -P | 3.31                          | 2.89                   | 0.115                         | 0.735             | Yes                      | 1.144                    | 110               | 0.255        |

<sup>a</sup> Levene test for equality of variances between the two groups compared

<sup>b</sup> Significance,  $p$ , of the Levene test – equality of variances is not assumed when  $p < 0.05$

<sup>c</sup> Student's t statistic

<sup>d</sup> Degrees of freedom

<sup>e</sup> Significance,  $p$ , of the t test

\* result significant -  $p < 0.05$

numbers of observations,  $n$ : final effluent  $n = 92$ , outfall  $n = 20$

Table 3.16 Summary of NH<sub>3</sub>-N concentrations (mg/l) and the results of normality tests, 1997 data

| Site Code | Site                | <i>n</i> <sup>a</sup> | Mean | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S <i>p</i> <sup>c</sup> | S-W <i>p</i> <sup>d</sup> |
|-----------|---------------------|-----------------------|------|--------------------|---------|---------|----------|---------------------------|---------------------------|
| 101       | St Brelade's Stream | 15                    | 0.06 | 0.12               | 0.01    | 0.50    | 3.4963   | 0.000                     | 0.000                     |
| 102       | La Haule A          | 6                     | 0.14 | 0.18               | 0.01    | 0.50    | 2.1911   | 0.022                     | 0.007                     |
| 103       | La Haule B          | 15                    | 0.08 | 0.12               | 0.01    | 0.50    | 3.5551   | 0.000                     | 0.000                     |
| 104       | St Peter's Valley   | 14                    | 0.09 | 0.14               | 0.01    | 0.50    | 2.5734   | 0.000                     | 0.000                     |
| 105       | Waterworks Valley   | 15                    | 0.20 | 0.42               | 0.01    | 1.70    | 3.6662   | 0.000                     | 0.000                     |
| 106       | Bellozanne Valley   | 14                    | 0.10 | 0.13               | 0.01    | 0.50    | 2.9140   | 0.001                     | 0.000                     |
| 301       | Bellozanne Outfall  | 6                     | 2.86 | 2.42               | 0.03    | 6.19    | -0.0956  | 0.200*                    | 0.419*                    |
|           | Final effluent      | 14                    | 3.70 | 2.43               | 0.07    | 8.63    | 0.5768   | 0.200*                    | 0.604*                    |

a *n* = number of observations

b Standard deviation

c significance, *p*, of Kolmogorov-Smirnov normality test

d significance, *p*, Shapiro-Wilk normality test

\* significance ≥ 0.05 indicates no significant departure from normality (values < 0.05 indicate significant departure from normality)

Table 3.17 Summary of NO<sub>2</sub>-N concentrations (mg/l) and the results of normality tests, 1997 data

| Site Code | Site                | <i>n</i> <sup>a</sup> | Mean | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S <i>p</i> <sup>c</sup> | S-W <i>p</i> <sup>d</sup> |
|-----------|---------------------|-----------------------|------|--------------------|---------|---------|----------|---------------------------|---------------------------|
| 101       | St Brelade's Stream | 15                    | 0.03 | 0.02               | 0.01    | 0.11    | 2.4462   | 0.006                     | 0.000                     |
| 102       | La Haule A          | 6                     | 0.06 | 0.04               | 0.01    | 0.12    | 0.4359   | 0.143*                    | 0.213*                    |
| 103       | La Haule B          | 15                    | 0.04 | 0.02               | 0.02    | 0.07    | 0.0758   | 0.041                     | 0.146*                    |
| 104       | St Peter's Valley   | 14                    | 0.04 | 0.03               | 0.01    | 0.12    | 1.4189   | 0.179*                    | 0.054*                    |
| 105       | Waterworks Valley   | 15                    | 0.10 | 0.09               | 0.02    | 0.38    | 2.4341   | 0.020                     | 0.001                     |
| 106       | Bellozanne Valley   | 14                    | 0.12 | 0.12               | 0.03    | 0.50    | 2.8992   | 0.001                     | 0.000                     |
| 301       | Bellozanne Outfall  | 6                     | 0.47 | 0.36               | 0.04    | 0.92    | -0.2650  | 0.200*                    | 0.338*                    |
|           | Final effluent      | 15                    | 0.54 | 0.42               | 0.05    | 1.64    | 1.3111   | 0.189*                    | 0.067*                    |

a *n* = number of observations

b Standard deviation

c significance, *p*, of Kolmogorov-Smirnov normality test

d significance, *p*, Shapiro-Wilk normality test

\* significance  $\geq 0.05$  indicates no significant departure from normality (values  $< 0.05$  indicate significant departure from normality)

Table 3.18 Summary of NO<sub>3</sub>-N concentrations (mg/l) and the results of normality tests, 1997 data

| Site Code | Site                | n <sup>a</sup> | Mean  | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S p <sup>c</sup> | S-W p <sup>d</sup> |
|-----------|---------------------|----------------|-------|--------------------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 15             | 10.60 | 2.79               | 4.98    | 14.98   | -0.1328  | 0.200*             | 0.658*             |
| 102       | La Haule A          | 6              | 11.89 | 3.52               | 7.09    | 15.92   | -0.3031  | 0.200*             | 0.596*             |
| 103       | La Haule B          | 15             | 16.57 | 3.33               | 11.87   | 23.37   | 0.9405   | 0.115*             | 0.090*             |
| 104       | St Peter's Valley   | 14             | 9.74  | 5.24               | 1.68    | 17.47   | 0.1467   | 0.200*             | 0.414*             |
| 105       | Waterworks Valley   | 15             | 9.91  | 3.45               | 4.62    | 18.05   | 0.9392   | 0.200*             | 0.360*             |
| 106       | Bellozanne Valley   | 14             | 14.10 | 3.74               | 8.80    | 24.54   | 1.6510   | 0.066*             | 0.037              |
| 301       | Bellozanne Outfall  | 6              | 21.94 | 9.47               | 4.71    | 33.58   | -1.2346  | 0.046              | 0.215*             |
|           | Final effluent      | 15             | 32.67 | 37.47              | 12.94   | 167.03  | 3.7672   | 0.000              | 0.000              |

a n = number of observations

b Standard deviation

c significance, p, of Kolmogorov-Smirnov normality test

d significance, p, Shapiro-Wilk normality test

\* significance ≥ 0.05 indicates no significant departure from normality (values < 0.05 indicate significant departure from normality)



Table 3.19 Summary of DAIN<sup>a</sup> concentrations (mg/l) and the results of normality tests, 1997 data

| Site Code | Site                | n <sup>b</sup> | Mean  | S. D. <sup>c</sup> | Minimum | Maximum | Skewness | K-S p <sup>d</sup> | S-W p <sup>e</sup> |
|-----------|---------------------|----------------|-------|--------------------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 15             | 10.70 | 2.80               | 5.00    | 15.12   | -0.1593  | 0.200*             | 0.648*             |
| 102       | La Haule A          | 6              | 12.08 | 3.47               | 7.11    | 16.06   | -0.3792  | 0.200*             | 0.682*             |
| 103       | La Haule B          | 15             | 16.69 | 3.32               | 11.93   | 23.45   | 0.9058   | 0.140*             | 0.120*             |
| 104       | St Peter's Valley   | 14             | 9.87  | 5.20               | 2.04    | 17.54   | 0.1429   | 0.200*             | 0.392*             |
| 105       | Waterworks Valley   | 15             | 10.20 | 3.55               | 4.73    | 18.23   | 0.7945   | 0.182*             | 0.536*             |
| 106       | Bellozanne Valley   | 14             | 14.31 | 3.65               | 9.34    | 24.66   | 1.7613   | 0.063*             | 0.024              |
| 301       | Bellozanne Outfall  | 6              | 25.27 | 11.46              | 4.78    | 40.29   | -1.0338  | 0.029              | 0.161*             |
|           | Final effluent      | 14             | 37.44 | 37.85              | 17.90   | 167.18  | 3.5701   | 0.000              | 0.000              |

a DAIN = dissolved available inorganic nitrogen – NH<sub>3</sub>-N + NO<sub>2</sub>-N + NO<sub>3</sub>-N

b n = number of observations

c Standard deviation

d significance, p, of Kolmogorov-Smirnov normality test

e significance, p, Shapiro-Wilk normality test

\* significance ≥ 0.05 indicates no significant departure from normality (values < 0.05 indicate significant departure from normality)

Table 3.20 Summary of PO<sub>4</sub>-P concentrations (mg/l) and the results of normality tests, 1997 data

| Site Code | Site                | n <sup>a</sup> | Mean | S. D. <sup>b</sup> | Minimum | Maximum | Skewness | K-S p <sup>c</sup> | S-W p <sup>d</sup> |
|-----------|---------------------|----------------|------|--------------------|---------|---------|----------|--------------------|--------------------|
| 101       | St Brelade's Stream | 15             | 0.11 | 0.11               | 0.01    | 0.50    | 3.3018   | 0.000              | 0.000              |
| 102       | La Haule A          | 6              | 0.19 | 0.17               | 0.05    | 0.50    | 1.7971   | 0.182*             | 0.068*             |
| 103       | La Haule B          | 15             | 0.47 | 1.17               | 0.09    | 4.67    | 3.8281   | 0.000              | 0.000              |
| 104       | St Peter's Valley   | 14             | 0.17 | 0.11               | 0.06    | 0.50    | 2.0783   | 0.006              | 0.002              |
| 105       | Waterworks Valley   | 15             | 0.16 | 0.14               | 0.01    | 0.50    | 1.1114   | 0.030              | 0.034              |
| 106       | Bellozanne Valley   | 14             | 0.07 | 0.13               | 0.01    | 0.50    | 3.4244   | 0.000              | 0.000              |
| 301       | Bellozanne Outfall  | 6              | 7.97 | 4.15               | 0.01    | 11.40   | -1.8590  | 0.094*             | 0.049              |
|           | Final effluent      | 15             | 8.60 | 2.89               | 0.50    | 11.60   | -1.9427  | 0.003              | 0.003              |

a n = number of observations

b Standard deviation

c significance, p, of Kolmogorov-Smirnov normality test

d significance, p, Shapiro-Wilk normality test

\* significance ≥ 0.05 indicates no significant departure from normality (values < 0.05 indicate significant departure from normality)

Table 3.21 Summary of comparisons between 1997 and 2007 data for NH<sub>3</sub>-N, NO<sub>2</sub>-N and NO<sub>3</sub>-N

| Site Code | Site                | Parameter          | Test <sup>a</sup>        | n <sup>b</sup><br>1997 | n <sup>b</sup><br>2007 | 1997<br>mg/l <sup>c</sup> | 2007<br>mg/l <sup>c</sup> | Equal<br>variances <sup>d</sup> | Statistic <sup>e</sup> | p <sup>f</sup> |
|-----------|---------------------|--------------------|--------------------------|------------------------|------------------------|---------------------------|---------------------------|---------------------------------|------------------------|----------------|
| 101       | St Brelade's Stream | NH <sub>3</sub> -N | M-W test                 | 15                     | 21                     | 0.02                      | 0.03                      |                                 | 99.5                   | 0.062          |
| 102       | La Haule A          | NH <sub>3</sub> -N | M-W test                 | 6                      | 18                     | 0.07                      | 0.03                      |                                 | 24.5                   | 0.047*         |
| 103       | La Haule B          | NH <sub>3</sub> -N | M-W test                 | 15                     | 20                     | 0.05                      | 0.03                      |                                 | 110.5                  | 0.191          |
| 104       | St Peter's Valley   | NH <sub>3</sub> -N | M-W test                 | 14                     | 20                     | 0.04                      | 0.03                      |                                 | 115.5                  | 0.396          |
| 105       | Waterworks Valley   | NH <sub>3</sub> -N | M-W test                 | 15                     | 20                     | 0.05                      | 0.03                      |                                 | 82.5                   | 0.023*         |
| 106       | Bellozanne Valley   | NH <sub>3</sub> -N | M-W test                 | 14                     | 20                     | 0.06                      | 0.03                      |                                 | 69.5                   | 0.012*         |
| 301       | Bellozanne Outfall  | NH <sub>3</sub> -N | t-test                   | 6                      | 20                     | 2.86                      | 20.40                     | No                              | -6.4                   | 0.000*         |
|           | Final Effluent      | NH <sub>3</sub> -N | t-test                   | 14                     | 92                     | 3.70                      | 23.00                     | No                              | -14.8                  | 0.000*         |
| 101       | St Brelade's Stream | NO <sub>2</sub> -N | t-test log <sub>10</sub> | 15                     | 21                     | 0.03                      | 0.02                      | Yes                             | 2.5                    | 0.018*         |
| 102       | La Haule A          | NO <sub>2</sub> -N | t-test log <sub>10</sub> | 6                      | 18                     | 0.04                      | 0.02                      | Yes                             | 2.1                    | 0.048*         |
| 103       | La Haule B          | NO <sub>2</sub> -N | t-test log <sub>10</sub> | 15                     | 20                     | 0.04                      | 0.01                      | Yes                             | 7.0                    | 0.000*         |
| 104       | St Peter's Valley   | NO <sub>2</sub> -N | t-test log <sub>10</sub> | 14                     | 20                     | 0.03                      | 0.02                      | No                              | 3.5                    | 0.002*         |
| 105       | Waterworks Valley   | NO <sub>2</sub> -N | t-test log <sub>10</sub> | 15                     | 20                     | 0.07                      | 0.02                      | Yes                             | 4.7                    | 0.000*         |
| 106       | Bellozanne Valley   | NO <sub>2</sub> -N | t-test log <sub>10</sub> | 14                     | 20                     | 0.09                      | 0.03                      | Yes                             | 4.6                    | 0.000*         |
| 301       | Bellozanne Outfall  | NO <sub>2</sub> -N | t-test                   | 6                      | 20                     | 0.48                      | 0.85                      | Yes                             | -2.1                   | 0.051          |
|           | Final Effluent      | NO <sub>2</sub> -N | t-test                   | 15                     | 92                     | 0.54                      | 0.72                      | Yes                             | -1.8                   | 0.082          |
| 101       | St Brelade's Stream | NO <sub>3</sub> -N | t-test                   | 15                     | 21                     | 10.6                      | 8.48                      | Yes                             | 2.0                    | 0.055          |
| 102       | La Haule A          | NO <sub>3</sub> -N | t-test                   | 6                      | 18                     | 11.89                     | 8.57                      | Yes                             | 2.2                    | 0.042*         |
| 103       | La Haule B          | NO <sub>3</sub> -N | t-test                   | 15                     | 20                     | 16.57                     | 12.4                      | Yes                             | 2.8                    | 0.008*         |
| 104       | St Peter's Valley   | NO <sub>3</sub> -N | t-test                   | 14                     | 20                     | 9.74                      | 10.59                     | No                              | -0.5                   | 0.590          |
| 105       | Waterworks Valley   | NO <sub>3</sub> -N | t-test                   | 15                     | 20                     | 9.9                       | 7.11                      | Yes                             | 2.7                    | 0.012*         |
| 106       | Bellozanne Valley   | NO <sub>3</sub> -N | t-test                   | 14                     | 20                     | 14.09                     | 13.21                     | Yes                             | 0.6                    | 0.579          |
| 301       | Bellozanne Outfall  | NO <sub>3</sub> -N | t-test                   | 6                      | 20                     | 21.94                     | 3.51                      | No                              | 4.7                    | 0.005*         |
|           | Final Effluent      | NO <sub>3</sub> -N | M-W test                 | 15                     | 92                     | 22.85                     | 5.20                      |                                 | 0.0                    | 0.000*         |

a M-W = Mann Whitney test, t-test = Student's t test, log<sub>10</sub> = test applied to log<sub>10</sub> transformed data

b n = number of observations

c Median when test = M-W, mean when test = t-test and geometric mean when test = t-test log<sub>10</sub> (geometric mean = 10<sup>x</sup> where x = mean of log<sub>10</sub> values)

d Equal variances are assumed when the Levene test of equal variances has significance, p, ≥ 0.05 (applies to Student's t-test only)

e Statistic = U for Mann-Whitney test and t for Student's t test

f p = significance of test - \* denotes a significant difference between medians or means compared (p < 0.05)

Table 3.22 Summary of comparisons between 1997 and 2007 data for DAIN and PO<sub>4</sub>-P

| Site Code | Site                | Parameter          | Test <sup>a</sup>        | n <sup>b</sup><br>1997 | n <sup>b</sup><br>2007 | 1997<br>mg/l <sup>c</sup> | 2007<br>mg/l <sup>c</sup> | Equal<br>variances <sup>d</sup> | Statistic <sup>e</sup> | p <sup>f</sup> |
|-----------|---------------------|--------------------|--------------------------|------------------------|------------------------|---------------------------|---------------------------|---------------------------------|------------------------|----------------|
| 101       | St Brelede's Stream | DAIN               | t-test                   | 15                     | 21                     | 10.7                      | 8.56                      | Yes                             | 2.0                    | 0.054          |
| 102       | La Haule A          | DAIN               | t-test                   | 6                      | 18                     | 12.08                     | 8.64                      | Yes                             | 2.3                    | 0.034*         |
| 103       | La Haule B          | DAIN               | t-test                   | 15                     | 20                     | 16.69                     | 12.48                     | Yes                             | 2.9                    | 0.007*         |
| 104       | St Peter's Valley   | DAIN               | t-test                   | 14                     | 20                     | 9.87                      | 10.63                     | No                              | -0.5                   | 0.623          |
| 105       | Waterworks Valley   | DAIN               | t-test                   | 15                     | 20                     | 10.2                      | 7.18                      | Yes                             | 2.8                    | 0.008*         |
| 106       | Bellozanne Valley   | DAIN               | t-test                   | 14                     | 20                     | 14.31                     | 13.29                     | Yes                             | 0.7                    | 0.517          |
| 301       | Bellozanne Outfall  | DAIN               | t-test                   | 6                      | 20                     | 25.27                     | 24.76                     | Yes                             | 0.1                    | 0.921          |
|           | Final Effluent      | DAIN               | M-W test                 | 14                     | 92                     | 26.55                     | 29.45                     |                                 | 629.0                  | 0.889          |
| 101       | St Brelede's Stream | PO <sub>4</sub> -P | M-W test                 | 15                     | 21                     | 0.08                      | 0.1                       |                                 | 124.0                  | 0.294          |
| 102       | La Haule A          | PO <sub>4</sub> -P | t-test log <sub>10</sub> | 6                      | 18                     | 0.14                      | 0.13                      | No                              | 0.1                    | 0.899          |
| 103       | La Haule B          | PO <sub>4</sub> -P | M-W test                 | 15                     | 20                     | 0.14                      | 0.13                      |                                 | 115.5                  | 0.254          |
| 104       | St Peter's Valley   | PO <sub>4</sub> -P | M-W test                 | 14                     | 20                     | 0.13                      | 0.17                      |                                 | 115.5                  | 0.396          |
| 105       | Waterworks Valley   | PO <sub>4</sub> -P | M-W test                 | 15                     | 20                     | 0.1                       | 0.1                       |                                 | 135.0                  | 0.633          |
| 106       | Bellozanne Valley   | PO <sub>4</sub> -P | M-W test                 | 14                     | 20                     | 0.02                      | 0.1                       |                                 | 47.5                   | 0.001*         |
| 301       | Bellozanne Outfall  | PO <sub>4</sub> -P | t-test                   | 6                      | 20                     | 7.97                      | 2.89                      | No                              | 2.9                    | 0.030*         |
|           | Final Effluent      | PO <sub>4</sub> -P | M-W test                 | 15                     | 92                     | 9.3                       | 3.4                       |                                 | 120.0                  | 0.000*         |

a M-W = Mann Whitney test, t-test = Student's t test, log<sub>10</sub> = test applied to log<sub>10</sub> transformed data

b n = number of observations

c Median when test = M-W, mean when test = t-test and geometric mean when test = t-test log<sub>10</sub> (geometric mean = 10<sup>x</sup> where x = mean of log<sub>10</sub> values)

d Equal variances are assumed when the Levene test of equal variances has significance, p, ≥ 0.05 (applies to Student's t-test only)

e Statistic = U for Mann-Whitney test and t for Student's t test

f p = significance of test - \* denotes a significant difference between medians or means compared (p < 0.05)

Table 3.23 Summary of annual NO<sub>3</sub>-N concentrations (mg/l) at Vallée des Vaux site 108 between 1997 and 2007

| Year | <i>n</i> <sup>a</sup> | Mean  | S. D. <sup>b</sup> | Minimum | Maximum |
|------|-----------------------|-------|--------------------|---------|---------|
| 1997 | 19                    | 11.83 | 2.87               | 6.80    | 16.02   |
| 1998 | 20                    | 13.79 | 3.43               | 7.90    | 18.90   |
| 1999 | 16                    | 13.75 | 3.36               | 7.61    | 18.91   |
| 2000 | 16                    | 13.37 | 2.40               | 8.49    | 16.90   |
| 2001 | 16                    | 12.72 | 2.16               | 9.67    | 16.13   |
| 2002 | 10                    | 12.17 | 1.79               | 9.92    | 14.34   |
| 2003 | 4                     | 10.71 | 2.71               | 8.36    | 13.95   |
| 2004 | 4                     | 10.61 | 1.58               | 8.29    | 11.75   |
| 2005 | 4                     | 10.28 | 2.52               | 8.13    | 13.78   |
| 2006 | 4                     | 9.04  | 3.01               | 5.87    | 12.42   |
| 2007 | 24                    | 10.27 | 2.90               | 3.90    | 14.20   |

a *n* = number of observations

b Standard deviation