**Table 1 |** Parameters with respective abbreviations Units, Holding time, Preservatives, and Analytical Methods

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameters** | **Abbreviations** | **Units** | **Holding Time** | **Preservatives** | **Analytical Methods/ Instruments** |
| Potential Hydrogen | pH |  | In Situ | None | pH Meter |
| Temperature | Temp | °C | In situ | None | Thermometer |
| Turbidity | TU | NTU | 4 hours | None | Water Analyzer |
| Color | Col | TCU | 4 hours | None | Water Analyzer |
| Dissolved Oxygen | DO | mg L-1 | In situ | None | DO Meter |
| Electric Conductivity | EC | µ S/cm | In Situ | None | TDS Meter |
| Total Dissolved Solids | TDS | mg L-1 | In situ | None | TDS Meter |
| Sulfate | 0 | mg L-1 | 4 days | 4 °C | UV/Visible Spectrometer |
| Chloride | Cl- | mg L-1 | 4days | 4 °C | APHA 2012, 22nd edition, part 4500 Cl- |
| Hardness | Ha | mg L-1 | 5days | 4 °C | APHA 2012, 22nd edition, part 2340 |
| Cadmium | Cd | mg L-1 | 30 days | HNO3, pH<2 | (AAS) Model: A ANALYST 800 |
| Copper | Cu | mg L-1 | 31 days | HNO3, pH<2 | (AAS) Model: A ANALYST 800 |
| Iron | Fe | mg L-1 | 32 days | HNO3, pH<2 | (AAS) Model: A ANALYST 800 |
| Manganese | Mn | mg L-1 | 33 days | HNO3, pH<2 | (AAS) Model: A ANALYST 800 |
| Lead | Pb | mg L-1 | 34 days | HNO3, pH<2 | (AAS) Model: A ANALYST 800 |
| Zinc | Zn | mg L-1 | 35 days | HNO3, pH<2 | (AAS) Model: A ANALYST 800 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 2 |** Physico-chemical results of wastewater parameters of Nalla Lai. ( n=19) | | | | | | | | | | | | | | | |
| **S. No** | **pH** | **Temp** | **Turbidity** | **DO** | **EC** | **S04** | **Cl-** | **Cd** | **Cu** | **Fe** | **Mn** | **Pb** | **Zn** | **BOD** | **COD** |
| 1 | 7.44 | 22 | 4610.20 | 0.94 | 1271 | 21.9 | 60 | 0.3 | 0.204 | 4.479 | 1.483 | 0.012 | 1.046 | 168 | 296 |
| 2 | 7.66 | 26 | 2725 | 2.05 | 1277 | 22.76 | 55.6 | 0.22 | BDL | 1.212 | 0.15 | 0.182 | 2.046 | 130 | 168 |
| 3 | 7.43 | 27 | 3113 | 1.03 | 1365 | 21.70 | 55.6 | 0.016 | BDL | 3.134 | 0.176 | BDL | 0.066 | 112 | 243 |
| 4 | 7.71 | 28 | 3689 | 0.33 | 1396 | 24.2 | 54.18 | BDL | 0.161 | 0.392 | 0.161 | BDL | 0.076 | 121 | 276 |
| 5 | 7.48 | 26 | 1940.24 | 0.74 | 1529 | 23.3 | 46.62 | BDL | 0.012 | BDL | 0.189 | 0.021 | 2.214 | 97 | 229 |
| 6 | 7.67 | 27 | 3635.84 | 0.20 | 1492 | 22.22 | 57.28 | BDL | 0.016 | BDL | 0.161 | BDL | 0.048 | 194 | 315 |
| 7 | 8.55 | 26 | 3645.65 | 1.24 | 1510 | 23.12 | 55.06 | BDL | BDL | 0.149 | 0.49 | BDL | 0.061 | 161 | 311 |
| 8 | 7.78 | 28 | 3459.74 | 1.25 | 1232 | 23.6 | 57.4 | 0.12 | BDL | BDL | 0.251 | BDL | 0.071 | 168 | 312 |
| 9 | 7.75 | 29 | 2313.49 | 0.26 | 1342 | 23.05 | 49.4 | BDL | BDL | 0.186 | 0.215 | BDL | 0.063 | 121 | 291 |
| 10 | 7.91 | 29 | 2111.69 | 1.04 | 1349 | 25.9 | 46.62 | 0.159 | 0.013 | 0.125 | 0.315 | BDL | 0.057 | 100 | 175 |
| 11 | 8.21 | 28 | 2543 | 1.65 | 1367 | 27.6 | 47.06 | 0.095 | BDL | 0.121 | 0.188 | BDL | 0.213 | 96 | 222 |
| 12 | 7.79 | 29 | 3130 | 0.63 | 1272 | 22.9 | 46.62 | 0.007 | BDL | 0.315 | 0.212 | 0.268 | 4.201 | 100 | 219 |
| 13 | 7.69 | 29 | 3343.74 | 0.35 | 1395 | 25.02 | 61.4 | 0.02 | BDL | BDL | 0.312 | BDL | 0.059 | 96 | 228 |
| 14 | 7.78 | 28 | 2981.84 | 0.81 | 1390 | 24.3 | 7.6 | 0.006 | 0.091 | BDL | 0.612 | BDL | 0.129 | 95 | 196 |
| 15 | 8.12 | 29 | 3399 | 1.14 | 1397 | 26.3 | 61.72 | 0.015 | BDL | 0.357 | 0.215 | 0.008 | 0.059 | 100 | 168 |
| 16 | 7.69 | 28 | 4215.73 | 0.69 | 1327 | 24.52 | 66.16 | BDL | 0.013 | 2.173 | 0.61 | BDL | 0.12 | 91 | 221 |
| 17 | 7.62 | 27 | 3386 | 0.26 | 1430 | 24.23 | 75.06 | 0.143 | BDL | 1.635 | 0.219 | BDL | 0.204 | 149 | 272 |
| 18 | 7.92 | 28 | 4155 | 2.80 | 1372 | 25.34 | 79.6 | 0.012 | BDL | 0.822 | 0.237 | BDL | 2.213 | 98 | 176 |
| 19 | 7.95 | 30 | 3490 | 2.67 | 1474 | 30.10 | 72.4 | 0.015 | BDL | 0.118 | 0.521 | BDL | 0.064 | 87 | 170 |

**Table 3 |** Descriptive statistics of wastewater samples of the study area: n=19

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Unit** | **Maximum** | **Minimum** | **Average** |
| pH |  | 8.55 | 7.43 | 7.8 |
| Temp | °C | 30 | 22 | 27.58 |
| Turbidity | NTU | 4610.20 | 1940.24 | 3257.27 |
| DO | mg L-1 | 2.80 | 0.20 | 1.06 |
| EC | µ S/cm | 1529 | 1232 | 1378.26 |
| SO4 | mg L-1 | 30.10 | 21.70 | 24.32 |
| Cl- | mg L-1 | 79.6 | 7.6 | 55.55 |
| Cd | mg L-1 | 0.3 | 0.006 | 0.09 |
| Cu | mg L-1 | 0.204 | 0.012 | 0.08 |
| Fe | mg L-1 | 4.48 | 0.12 | 1.09 |
| Mn | mg L-1 | 1.48 | 0.15 | 0.35 |
| Pb | mg L-1 | 0.268 | 0.008 | 0.10 |
| Zn | mg L-1 | 4.20 | 0.05 | 0.68 |
| BOD | mg L-1 | 194 | 87 | 120.21 |
| COD | mg L-1 | 315 | 168 | 240.15 |

**Table 4 |** Physicochemical and Microbial Results of Groundwater of Study Area. (n=49)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.No** | **pH** | **Tem** | **TU** | **Color** | **DO** | **EC** | **TDS** | **SO4** | **Cl-** | **Ha** | **Cd** | **Cu** | **Fe** | **Mn** | **Pb** | **Zn** | **E.coli** |
| 1 | 7.25 | 22 | 0 | 4.4 | 5.7 | 356 | 291 | 24.14 | 12.7 | 616 | BDL | 0.11 | 0.26 | 0.038 | 0.003 | 0.52 | -ve |
| 2 | 6.39 | 24 | 0 | 10.04 | 3.28 | 1121 | 958 | 36.7 | 13.3 | 1065 | 0.028 | 0.139 | 4.757 | 0.685 | 0.002 | 2.26 | -ve |
| 3 | 7.34 | 24 | 0 | 3.66 | 5.83 | 323 | 267 | 18.34 | 11.32 | 616 | BDL | BDL | BDL | 0.036 | BDL | BDL | -ve |
| 4 | 7.45 | 24 | 0 | 4.79 | 5.64 | 302 | 254 | 26.11 | 9.1 | 552 | BDL | BDL | 0.219 | BDL | BDL | BDL | -ve |
| 5 | 7.35 | 25 | 0 | 4.62 | 4.58 | 619 | 498 | 45 | 23.5 | 536 | BDL | BDL | 0.101 | BDL | BDL | BDL | -ve |
| 6 | 7.41 | 23 | 0 | 5.06 | 6.48 | 772 | 584 | 41.33 | 49.7 | 1121 | BDL | BDL | BDL | BDL | BDL | 0.18 | -ve |
| 7 | 7.59 | 21 | 0 | 4.39 | 8.4 | 405 | 319 | 37.18 | 21.1 | 596 | BDL | BDL | BDL | BDL | 0.004 | 0.131 | -ve |
| 8 | 7.23 | 22 | 0 | 4.72 | 5.8 | 407 | 322 | 46.24 | 19 | 656 | BDL | BDL | BDL | BDL | BDL | BDL | -ve |
| 9 | 7.65 | 21 | 0 | 4.11 | 5.87 | 433 | 293 | 21.4 | 13.1 | 372 | BDL | BDL | BDL | BDL | BDL | 0.096 | -ve |
| 10 | 7.29 | 25 | 0 | 5.7 | 6.2 | 540 | 449 | 29.1 | 14 | 568 | 0.005 | BDL | 0.529 | BDL | BDL | 2.476 | -ve |
| 11 | 7.47 | 21 | 0 | 7.73 | 5.36 | 289 | 229 | 18.9 | 8.21 | 332 | BDL | BDL | 0.345 | BDL | BDL | BDL | -ve |
| 12 | 8.19 | 24 | 0 | 5.86 | 6.68 | 1380 | 996 | 100.2 | 64.4 | 1528 | 0.009 | BDL | 1.512 | BDL | BDL | 0.089 | +ve |
| 13 | 7.22 | 22 | 0 | 10.24 | 6.19 | 1408 | 1138 | 59.64 | 107 | 1122 | 0.005 | 0.038 | BDL | BDL | 0.038 | BDL | -ve |
| 14 | 8.3 | 22 | 0 | 5.91 | 5.9 | 637 | 595 | 22.6 | 17.1 | 1076 | BDL | BDL | BDL | 0.344 | BDL | 0.093 | -ve |
| 15 | 6.41 | 27 | 0 | 4.84 | 3.85 | 1019 | 844 | 28 | 22.7 | 896 | BDL | BDL | BDL | BDL | BDL | BDL | -ve |
| 16 | 7.3 | 21 | 0 | 5.17 | 5.46 | 446 | 358 | 34 | 19.32 | 564 | 0.021 | BDL | BDL | BDL | BDL | 0.014 | -ve |
| 17 | 7.65 | 23 | 0 | 5.78 | 4.39 | 722 | 419 | 20.1 | 12.21 | 124 | 0.007 | BDL | 0.786 | BDL | BDL | 0.23 | +ve |
| 18 | 7.7 | 22 | 0 | 4.74 | 6.93 | 442 | 360 | 14.7 | 25.1 | 556 | 0.009 | BDL | 0.134 | BDL | BDL | 0.404 | -ve |
| 19 | 7.35 | 22 | 0 | 4.63 | 5.61 | 731 | 551 | 16.8 | 17.32 | 976 | BDL | BDL | 0.396 | BDL | BDL | 0.071 | -ve |
| 20 | 6.86 | 26 | 0 | 6.22 | 3.73 | 549 | 451 | 22.2 | 29.1 | 604 | BDL | BDL | BDL | BDL | BDL | 0.092 | -ve |
| 21 | 7.25 | 21 | 0 | 4.96 | 5.46 | 905 | 691 | 44.34 | 28.2 | 1144 | BDL | BDL | BDL | 0.162 | BDL | 2.413 | -ve |
| 22 | 6.59 | 25 | 0 | 5 | 4.45 | 783 | 609 | 15.7 | 10.9 | 776 | 0.005 | BDL | 2.914 | 0.412 | BDL | 0.121 | -ve |
| 23 | 7.35 | 22 | 0 | 5.39 | 6.33 | 549 | 439 | 24.45 | 20.43 | 656 | 0.018 | BDL | BDL | 0.189 | 0.04 | 0.09 | -ve |
| 24 | 7.41 | 23 | 0 | 4.5 | 5.25 | 794 | 581 | 30.41 | 37.53 | 1064 | BDL | BDL | BDL | 0.218 | BDL | BDL | -ve |
| 25 | 7.07 | 24 | 0 | 4.94 | 5.88 | 566 | 464 | 29.91 | 28 | 776 | BDL | BDL | BDL | BDL | BDL | 0.386 |  |
| 26 | 7.28 | 25 | 0 | 5.13 | 6.41 | 1173 | 885 | 37.84 | 74.61 | 1564 | BDL | BDL | BDL | BDL | BDL | 0.095 | -ve |
| 27 | 7.40 | 22 | 0 | 4.99 | 6.15 | 375 | 301 | 20.42 | 10.7 | 520 | BDL | BDL | BDL | 0.091 | BDL | BDL |  |
| 28 | 7.32 | 22 | 0 | 17.89 | 4.4 | 894 | 719 | 21.54 | 77.72 | 928 | 0.012 | BDL | 1.965 | 0.853 | BDL | 0.015 | -ve |
| 29 | 7.25 | 22 | 0 | 6.11 | 5.89 | 907 | 485 | 31.4 | 36.64 | 680 | 0.009 | BDL | BDL | 0.321 | BDL | 5.108 |  |
| 30 | 7.68 | 24 | 0 | 5.75 | 5.35 | 222 | 201 | 14.5 | 7.6 | 384 | BDL | BDL | BDL | 0.085 | BDL | 3.95 |  |
| 31 | 7.61 | 25 | 0 | 5.77 | 6.71 | 306 | 346 | 19.63 | 13.8 | 372 | BDL | BDL | BDL | 0.418 | BDL | BDL | -ve |
| 32 | 7.16 | 28 | 0 | 5.18 | 4.36 | 762 | 611 | 28.65 | 59.73 | 1132 | BDL | BDL | 1.249 | 0.195 | BDL | BDL | -ve |
| 33 | 7.48 | 23 | 0 | 6.16 | 5.63 | 593 | 482 | 17.9 | 34.64 | 724 | 0.019 | BDL | BDL | 0.131 | BDL | 1.821 | -ve |
| 34 | 7.53 | 22 | 0 | 6.4 | 5.16 | 494 | 325 | 33.17 | 12 | 720 | BDL | BDL | BDL | 0.629 | BDL | 2.981 | +ve |
| 35 | 6.45 | 26 | 0 | 7.45 | 4.09 | 868 | 691 | 38.31 | 34.2 | 1044 | 0.009 | BDL | 2.933 | 0.512 | BDL | 1.251 | -ve |
| 36 | 7.53 | 25 | 0 | 5.39 | 6.56 | 472 | 383 | 25.6 | 17.54 | 480 | BDL | BDL | BDL | 0.091 | BDL | BDL |  |
| 37 | 7.54 | 24 | 0 | 5.63 | 6.34 | 332 | 272 | 23.9 | 12.21 | 452 | BDL | BDL | BDL | 0.089 | BDL | 0.018 | +ve |
| 38 | 7.48 | 23 | 0 | 5.36 | 5.23 | 445 | 366 | 20.4 | 18.7 | 464 | BDL | BDL | BDL | 0.091 | BDL | BDL |  |
| 39 | 7.76 | 22 | 0 | 4.74 | 6.43 | 376 | 391 | 17.44 | 13.1 | 564 | BDL | BDL | BDL | 0.082 | BDL | 1.036 |  |
| 40 | 7.47 | 25 | 0 | 5.94 | 5.31 | 387 | 301 | 18.09 | 10 | 480 | 0.016 | BDL | BDL | 0.149 | BDL | 0.785 | +ve |
| 41 | 7.64 | 21 | 0 | 6.56 | 6.08 | 473 | 288 | 14.21 | 8.43 | 524 | 0.021 | BDL | BDL | 0.164 | BDL | 0.25 |  |
| 42 | 7.52 | 23 | 0 | 4.9 | 5.75 | 468 | 392 | 21.36 | 28 | 412 | 0.023 | BDL | BDL | 0.301 | BDL | 0.018 |  |
| 43 | 7.29 | 24 | 0 | 5.26 | 5.15 | 327 | 375 | 15.07 | 10.7 | 628 | 0.036 | BDL | BDL | 0.12 | 0.025 | 1.337 |  |
| 44 | 7.44 | 22 | 0 | 4.9 | 6.78 | 462 | 378 | 20.37 | 19.32 | 408 | 0.008 | BDL | BDL | 0.104 | BDL | 0.041 | -ve |
| 45 | 7.26 | 22 | 0 | 8.17 | 4.53 | 701 | 597 | 25.52 | 50 | 448 | 0.009 | BDL | 0.316 | 0.569 | BDL | 3.242 |  |
| 46 | 7.49 | 24 | 0 | 5.31 | 5.49 | 524 | 435 | 32.19 | 24.2 | 576 | 0.007 | BDL | BDL | 0.098 | BDL | 0.051 | -ve |
| 47 | 7.19 | 23 | 0 | 4.43 | 5.17 | 705 | 503 | 37.17 | 36.2 | 844 | 0.021 | BDL | BDL | 0.161 | BDL | 0.01 | +ve |
| 48 | 7.12 | 23 | 0 | 5.21 | 5.75 | 653 | 535 | 27.86 | 43.74 | 788 | BDL | BDL | BDL | 0.17 | BDL | 6.195 |  |
| 49 | 7.13 | 24 | 0 | 5.81 | 5.56 | 807 | 506 | 17.7 | 68.17 | 732 | BDL | BDL | BDL | 0.269 | BDL | 0.2 |  |

|  |  |
| --- | --- |
| **Legends** | |
| -ve | *E. coli* is detected in analyzed water sample |
| +ve | *E. coli* is not detected in analyzed water sample |

**Table 5 |** Descriptive Statistics of Groundwater Samples of Study Area: n=49

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Unit** | **Maximum** | **Minimum** | **Average** |
| pH |  | 8.3 | 6.39 | 7.35 |
| Temp | °C | 28 | 21 | 23.27 |
| TU | NTU | 0 | 0 | 0 |
| Color | TCU | 17.89 | 3.66 | 5.83 |
| DO | mg L-1 | 8.4 | 3.28 | 5.58 |
| EC | µ S/cm | 1408 | 222 | 616.83 |
| TDS | mg L-1 | 1138 | 201 | 484.24 |
| SO4 | mg L-1 | 100.2 | 14.1 | 28.2 |
| Cl- | mg L-1 | 107 | 7.6 | 27.7 |
| Ha | mg L-1 | 1564 | 124 | 709 |
| Cd | mg L-1 | 0.036 | 0.005 | 0.01 |
| Cu | mg L-1 | 0.139 | 0.038 | 0.09 |
| Fe | mg L-1 | 4.76 | 0.101 | 1.23 |
| Mn | mg L-1 | 0.85 | 0.04 | 0.25 |
| Pb | mg L-1 | 0.04 | 0.002 | 0.02 |
| Zn | mg L-1 | 6.2 | 0.01 | 1.06 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **pH** | **Tem** | **Color** | **DO** | **EC** | **TDS** | **SO4** | **Cl-** | **Ha** | **Cd** | **Cu** | **Fe** | **Mn** | **Pb** | **Zn** |
| **pH** | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Tem** | -0.4314 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Color** | -0.1536 | -0.09521 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| **DO** | 0.61907 | -0.41903 | -0.336 | 1 |  |  |  |  |  |  |  |  |  |  |  |
| **EC** | -0.3052 | 0.17838 | 0.36722 | -0.2494 | 1 |  |  |  |  |  |  |  |  |  |  |
| **TDS** | -0.3402 | 0.23945 | 0.40717 | -0.2744 | 0.96017 | 1 |  |  |  |  |  |  |  |  |  |
| **SO4** | 0.05994 | 0.04074 | 0.06407 | 0.11531 | 0.63748 | 0.6086 | 1 |  |  |  |  |  |  |  |  |
| **Cl-** | -0.0937 | 0.09486 | 0.45553 | -0.0048 | 0.74195 | 0.7187 | 0.49175 | 1 |  |  |  |  |  |  |  |
| **Ha** | -0.1809 | 0.20162 | 0.16708 | -0.0713 | 0.78764 | 0.8047 | 0.60882 | 0.6266 | 1 |  |  |  |  |  |  |
| **Cd** | -0.1012 | -0.09663 | -0.0686 | -0.2114 | -0.3257 | -0.216 | -0.2264 | -0.34 | -0.0304 | 1 |  |  |  |  |  |
| **Cu** | -0.7 | 0.72164 | -0.2679 | -0.8215 | -0.4865 | -0.4297 | -0.8027 | -0.959 | -0.3373 | 1 | 1 |  |  |  |  |
| **Fe** | -0.7244 | 0.39459 | 0.602 | -0.6195 | 0.65067 | 0.719 | 0.1863 | 0.0116 | 0.51514 | 0.6942 | 1 | 1 |  |  |  |
| **Mn** | -0.3652 | -0.00995 | 0.77172 | -0.6052 | 0.59983 | 0.6368 | 0.27393 | 0.3975 | 0.36613 | -0.15915 | 1 | 0.64972 | 1 |  |  |
| **Pb** | 0.30359 | -0.05465 | 0.18443 | 0.13458 | 0.26353 | 0.2606 | 0.16818 | 0.5474 | 0.16108 | -0.59553 | -0.9669 | -1 | -0.3747 | 1 |  |
| **Zn** | -0.1724 | -0.0151 | 0.06282 | -0.1609 | 0.03768 | 0.0128 | -0.0104 | -0.009 | -0.0484 | -0.06143 | 1 | 0.12878 | 0.09132 | -0.32646 | 1 |

**Table 6 |** Correlation Matrix of Physicochemical Parameters of Groundwater of Study Area.