Wastewater management practices at Antarctic stations: Preliminary survey results

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Information Paper prepared by COMNAP

***Summary***

A COMNAP survey was undertaken with the purpose to understand current wastewater management practices on stations within the Antarctic Treaty area by COMNAP Member national Antarctic programmes. All Member programmes with stations responded to the survey (Appendix 1).

Overall, survey results indicate that forty-six (46) stations use a wastewater treatment system to manage wastewater, using one or more treatment methods, comprising 69% of the stations operated by COMNAP Member national Antarctic programmes in the Antarctic Treaty area. Additionally, the survey indicates that, out of the forty-six (46) stations having a wastewater treatment system, forty-three (43) stations (93%) are using pre-treatment methods, thirty-six (36) stations (78%) are using primary treatments, thirty-seven (37) stations (80%) are using secondary treatments, and thirty-one (31) stations (67%) are using tertiary treatment or filtration methods.

***Background***

Annex III “Waste Disposal and Waste Management” to the Environmental Protocol obliges Parties to reduce as far as practicable the amount of wastes produced or disposed of in the Antarctic Treaty area (Article 1(2)). Article 5(1) “Sewage and domestic liquid wastes may be discharged directly into the sea…provided that:” *inter alia* “(b) large quantities of such wastes (generated in a station where the average weekly occupancy over the austral summer is approximately 30 individuals or more) shall be treated at least by maceration.”

Following up from Gröndahl et al. (2009)[[1]](#footnote-1) on waste disposal practices at stations and from the “Advancing Antarctic Station Waste Water Management Workshop”, held by COMNAP on 28 August, 2014, as part of the COMNAP Annual General Meeting (AGM) in Christchurch, New Zealand, as presented in ATCM XXXVIII (2015) IP074, COMNAP undertook a survey in 2021/22 to understand current wastewater management practices on stations within the Antarctic Treaty area by COMNAP Member national Antarctic programmes. Preliminary results are presented in this Information Paper. COMNAP have also asked its membership to provide waste and wastewater management data into the COMNAP database since August 2021.

***Survey***

The COMNAP database lists (as of 26 October 2021) twenty-nine (29) national Antarctic programmes as operating an open Antarctic station. The COMNAP Secretariat conducted a survey through the twenty-nine (29) COMNAP Member national Antarctic programme Managers which were listed in the COMNAP database as administering one or more open stations within the Antarctic Treaty area. A total of sixty-seven (67) stations, thirty-nine (39) of which are year-round and twenty-eight (28) are seasonal, have been included in the survey which opened on 26 October 2021 and closed, with an extended deadline, on 1 March 2022. Answers to some of the survey questions for the sixty-seven (67) stations have been recorded and presented in Appendix 2.

***Results***

This Information Paper presents preliminary results predominately from Section 3 of the survey. In the survey, a non-exhaustive list of examples was provided with each question as was the opportunity to select “other” and add free text in response.

*Question 7: Does this station have a wastewater treatment system? Yes or No*

There were forty-six (46) “Yes” responses to this question. Forty-six (46) of the sixty-seven (67) stations included in the COMNAP Database have a wastewater treatment system, using one or more treatment methods, comprising 69% of the stations operated by COMNAP Member national Antarctic programmes in the Antarctic Treaty area. Thirty-one (31) of the stations which stated to have a wastewater treatment system are year-round and fifteen (15) are seasonal. Out of the twenty-one (21) stations that do not have a wastewater treatment system, eight (8) are year-round and thirteen (13) are seasonal. 79% of year-round stations have a wastewater treatment system, meaning 21% lack a wastewater treatment system; it is a 16% increase since 2009[[2]](#footnote-2). A total of 54% of seasonal stations have a wastewater treatment system, meaning 46% lack a wastewater treatment system; it is a 23% increase since the 2009[[3]](#footnote-3) survey.

*Question 9: Is pre-treatment used? Yes or No  
(e.g., separation of oils/fats, removal of rags/solids, maceration, other)*

Forty-three (43) of the forty-six (46) stations which have a wastewater treatment system recorded an affirmative answer “Yes”, meaning 93% of the stations are using pre-treatment methods as part of their wastewater management practises.

*Question 10: Is primary treatment used? Yes or No  
(e.g., settlement, other)*

Thirty-six (36) of the forty-six (46) stations which have a wastewater treatment system recorded an affirmative answer “Yes”, meaning 78% of the stations are using primary treatment methods as part of their wastewater management practises.

*Question 11: Is secondary treatment used? Yes or No  
(e.g., biolfilm, aeration, membrane filtration, other)*

Thirty-seven (37) of the forty-six (46) stations which have a wastewater treatment system recorded an affirmative answer “Yes”, meaning 80% of the stations are using secondary treatment methods as part of their wastewater management practises.

*Question 12: Is tertiary treatment used? Yes or No  
(e.g., Ozone, UV radiation, chlorination, reverse osmosis, hydrogen peroxide, other advanced oxidation processes such as fenton catalytic reactions, etc.)*

Thirty (30) of the forty-six (46) stations which have a wastewater treatment system recorded an affirmative answer “Yes” to Question 12, meaning 65% of the stations are using tertiary treatment as part of their wastewater management practises. In addition, one station replied “No” to Question 12 but “Yes” to Question 13 indicating that tertiary filtration was used, meaning thirty-one (31) of 46 stations (67%) used a tertiary-level process (either treatment or filtration or both).

***Preliminary Comments and Conclusions***

Further analysation of the survey results is required. Preliminary results confirm that implementation and use of wastewater treatment systems at Antarctic stations has increased since the time of the last survey carried out in 2009 by 16% for year-round stations and by 23% for seasonal stations. In general, there is a higher level of wastewater treatment use at year-round stations as compared with seasonal stations. Overall, processes continue to improve with more stations installing and using more sophisticated treatment methods than ever before. In addition to the increased use of treatment systems, a range of other positive practices have also been implemented which aim to reduce the amount of wastewater generated in the first instance or which use grey water recycling systems and operations which also decreases both wastewater discharge volumes and fresh water volume usage.

***Appendix 1: COMNAP Wastewater Management Practices Survey***

|  |  |
| --- | --- |
| **Wastewater Management Practices**    The aims of this survey are to:    (i) understand current wastewater management practices on stations within the Antarctic Treaty area by COMNAP Member national Antarctic programmes; and  (ii) facilitate sharing of information.    As a result of the survey, it is hoped the information gathered will assist in further developing best practice related to the implemented wastewater treatment systems and practical and technical information: what worked well, what did not work well and why, and cost/benefit issues.    Please complete the survey for each station that your programme operates in the Antarctic Treaty area.    The questionnaire has been prepared by the COMNAP Environmental Protection Expert Group, September 2021 and reviewed by the COMNAP EXCOM. | |
| **Section 1: Respondent information (Answers required)** | |
| **Q1** Your name: | *Textbox* |
| **Q2** Your e-mail address: | *Textbox* |
| **Section 2: Station information (Answers required)** | |
| **Q3** National Antarctic Programme | *Dropdown list in Qualtrics taken from the COMNAP database.* |
| **Q4** Station (Choose one for this survey):  *A separate survey will need to be filled out for every station.* | *Dropdown list in Qualtrics taken from the COMNAP database* |
| **Q5** Seasonality | *Seasonal or Year-Round* |
| **Q6** Peak population number | *Textbox* |
| **Q7** Does this station have a wastewater treatment system? | *Y (Go to section 3, Q8)*  *N (Go to section 5, Q32)* |
| **Section 3: Wastewater treatment systems (Answers required)** | |
| **Q8** What wastewater treatment system technology is in use?  *(e.g., maceration only, septic tank, sewage tank, sewage treatment plant, effluent treatment, sludge treatment)*  Please provide the name of any treatment technology used. | *Textbox* |
| **Q9** Is pre-treatment used?  *(e.g., separation of oils/fats, removal of rags/solids, maceration, other)*  If yes, please provide what type of pre-treatment is used in the textbox provided. | *N/Y (textbox with Y)* |
| **Q10** Is primary treatment used?  (e.g., settlement, other)  If yes, please provide what type of primary treatment is used in the textbox provided. | *N/Y (textbox with Y)* |
| **Q11** Is secondary treatment used?  *(e.g., biolfilm, aeration, membrane filtration, other)*  If yes, please provide what type of secondary treatment is used in the textbox provided. | *N/Y (textbox with Y)* |
| **Q12** Is tertiary treatment used?  *(e.g., Ozone, UV radiation, chlorination, reverse osmosis, hydrogen peroxide, other advanced oxidation processes such as fenton catalytic reactions, etc.)*  If yes, please provide what type of tertiary treatment is used in the textbox provided. | *N/Y (textbox with Y)* |
| **Q13** Is tertiary filtration used?  *(e.g., activated carbon, sand/gravel, ultrafiltration, microfiltration, other)*  If yes, please provide what type of tertiary filtration is used in the textbox provided. | *N/Y (textbox with Y)* |
| **Q14** Is any other additional treatment used?  If yes, please provide what type is used in the textbox provided. | *N/Y (textbox with Y)* |
| **Q15** Are there any highlights or lessons learned that you would like to share about the above wastewater treatment types?  (*e.g., innovative technologies that have proven to be particularly successful*). *This is to understand if the system has been efficient.*  Please describe in detail. | *Textbox* |
| **Q16** Do you have any comments on the reliability, or the maintenance requirements, for the particular system in use? (*This is to understand if the system has been dependable/reliable in Antarctic conditions*). | *Textbox* |
| **Q17** What year was the wastewater treatment system installed? | *Dropdown list including ‘Unknown’, and all other years between 1957 and 2021.*  *If “unknown” is chosen, go to Q18.*  *If a “year” is chosen, go to Q19* |
| **Q18** Please provide an estimation of when the wastewater treatment was installed | *Unknown, but installed after 2005*  *Unknown, but installed before 2005* |
| **Q19** Is your programme currently in the development or implementation stage of upgrading the station’s wastewater management treatment facilities? | *Y/N* |
| **Q20** During what months does the wastewater treatment system operate? | *J, F, M, A, M, J, J, A, S, O, N, D (all, none or any can be selected).* |
| **Q21** Where is any wastewater disposed of? | *Choose as many of the following options:*   * *Coastal water's edge - at or above high tide mark* * *Coastal waster's edge - below high tide mark* * *Below the low tide mark* * *Top of ice cliff* * *Into permanent ice close to the station* * *Other, please describe in the textbox below (textbox provided)* |
| **Q22** What is the volume of wastewater discharge per month (Litres)? | *J, F, M, A, M, J, J, A, S, O, N, D (all, none, or any can have a value added).* |
| **Q23** Does the total volumes you have indicated above include wastewater from field activities? | *Y/N* |
| **Q24** What is the method of sewage sludge/solids disposal or removal? | *Choose as many as the following options:*   * *Incineration* * *Removal from Antarctica* * *Released onto ice* * *Released into sea* * *Other, please describe in the box below (textbox provided)* |
| **Q25** Does your programme/scientists do any monitoring of the wastewater effluent quality? | *Y/N* |
| **Q26** Does your programme/scientists do any monitoring of the impacts of the wastewater effluent on the environment? | *Y/N* |
| **Section 4: Operational challenges (Answers non-compulsory)** | |
| **Q27** What is the main/primary operational challenge (if any) related to the wastewater treatment system currently installed at the station? | *Textbox* |
| **Q28** Is the wastewater treatment system usually able to cope with a rapid change (increase or decrease) in the number of personnel on station? | *Textbox* |
| **Q29** Are there measures in place to prevent or reduce infestations of the station’s sewage treatment system from non-native invertebrates (e.g., flies)?  *You may provide further comment in the boxes provided.* | *Y textbox provided*  *N textbox provided* |
| **Q30** Do you have any protocols, technologies or filters in place to capture microplastics before wastewater is discharged into the Antarctic environment?  *You may provide further comment in the boxes provided.* | *Y textbox provided*  *N textbox provided* |
| **Q31** Any additional comments? | *Textbox provided* |
| **Section 5: Water usage (Answers required)** | |
| **Q32** What is the primary source of water used on the station? | *Choose one from the following:*   * *Melted snow/ice* * *Lake* * *Seawater via reverse osmosis* * *Other (textbox provided)* |
| **Q33** Is wastewater recycled on station in any way? | *If Yes (Q34)*  *If No (Q35)* |
| **Q34** For what purposes is wastewater recycled? | *Textbox provided* |
| **Q35** What barriers exist that prevent wastewater recycling? | *Textbox provided* |
| **Q36** How much water is used on the station per month (Litres)? | *J, F, M, A, M, J, J, A, S, O, N, D (all, none, or any can have a value added).* |
| **THANK YOU**for completing the Wastewater Management Practices survey. Your answers have been received.  If your programme operates only this station in the Antarctic Treaty area, then you are done. If your programme operates more than one station in the Antarctic Treaty area, and if you now want to record information for another station, please click here to start the survey for the next station. Otherwise, you can sign back in at another time to complete the survey for your programmes’ remaining station(s).  For any information you might require, please contact [sec@comnap.aq](mailto:sec@comnap.aq). | |

***Appendix 2: Antarctic stations in the COMNAP Database as of 26 October 2021 and summarised responses to wastewater treatments questions 7, 9, 10, 11 and 12.***

| Station Name | Country | Station Latitude (DD) | Station Longitude (DD) | Seasonality | Does this station have a wastewater treatment system? | Is pre-treatment used? | Is primary treatment used? | Is secondary treatment used? | Is tertiary treatment used? |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Belgrano II | Argentina | -77.87 | -34.62 | Year-Round | No |  |  |  |  |
| Carlini | Argentina | -62.24 | -58.66 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Esperanza | Argentina | -63.39 | -56.99 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Marambio | Argentina | -64.24 | -56.62 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Orcadas | Argentina | -60.73 | -44.73 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| San Martín | Argentina | -68.13 | -67.10 | Year-Round | No |  |  |  |  |
| Casey Station | Australia | -66.28 | 110.52 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Davis Station | Australia | -68.57 | 77.96 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Mawson Station | Australia | -67.60 | 62.87 | Year-Round | Yes | Yes | Yes | Yes | No |
| Princess Elisabeth Antarctica | Belgium | -71.94 | 23.34 | Seasonal | Yes | Yes | Yes | Yes | Yes |
| Estacao Antartica Comandante Ferraz | Brazil | -62.08 | -58.39 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| St. Kliment Ohridski Base | Bulgaria | -62.64 | -60.36 | Seasonal | Yes | Yes | No | Yes | No |
| Base Naval Antártica Arturo Prat | Chile | -62.47 | -59.66 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Estación Marítima Bahía Fildes | Chile | -62.20 | -58.96 | Year-Round | Yes | No | Yes | Yes | Yes |
| Dr. Guillermo Mann | Chile | -62.46 | -60.77 | Seasonal | No |  |  |  |  |
| Base Antártica Presidente Gabriel González Videla | Chile | -64.82 | -62.85 | Seasonal | No |  |  |  |  |
| O'Higgins Base | Chile | -63.32 | -57.89 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Base Aérea Antártica Presidente Eduardo Frei Montalva | Chile | -62.20 | -58.96 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Professor Julio Escudero | Chile | -62.20 | -58.96 | Seasonal | Yes | Yes | Yes | Yes | Yes |
| Risopatron | Chile | -62.38 | -59.66 | Seasonal | No |  |  |  |  |
| Yelcho | Chile | -64.87 | -63.58 | Seasonal | No |  |  |  |  |
| Great Wall Station | China | -62.21 | -58.96 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Kunlun Station | China | -80.41 | 77.11 | Seasonal | Yes | Yes | Yes | Yes | No |
| Zhongshan Station | China | -69.37 | 76.37 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Johann Gregor Mendel Czech Antarctic Station | Czech Republic | -63.80 | -57.88 | Seasonal | Yes | Yes | Yes | No | No |
| Pedro Vicente Maldonado Station | Ecuador | -62.44 | -59.74 | Seasonal | Yes | Yes | Yes | No | No |
| Aboa Station | Finland | -73.04 | -13.40 | Seasonal | No |  |  |  |  |
| Dumont d'Urville Station | France | -66.66 | 140.00 | Year-Round | No |  |  |  |  |
| Robert Guillard | France | -66.68 | 139.90 | Seasonal | No |  |  |  |  |
| Gondwana Station | Germany | -74.63 | 164.22 | Seasonal | Yes | Yes | Yes | No | No |
| Kohnen Station | Germany | -75.00 | 0.06 | Seasonal | No |  |  |  |  |
| Neumayer-Station III | Germany | -70.66 | -8.27 | Year-Round | Yes | Yes | No | Yes | Yes |
| Bharati Station | India | -69.40 | 76.19 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Maitri Station | India | -70.76 | 11.73 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Concordia Station | Italy/France | -75.09 | 123.33 | Year-Round | Yes | Yes | No | Yes | Yes |
| Stazione Mario Zucchelli | Italy | -74.69 | 164.11 | Seasonal | Yes | Yes | Yes | Yes | Yes |
| Syowa Station | Japan | -69.00 | 39.58 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Scott Base Station | New Zealand | -77.84 | 166.76 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Troll Station | Norway | -72.01 | 2.53 | Year-Round | Yes | Yes | Yes | Yes | No |
| Machu Picchu Station | Peru | -62.09 | -58.47 | Seasonal | Yes | Yes | No | No | No |
| Henryk Arctowski Polish Antarctic Station | Poland | -62.15 | -58.47 | Year-Round | No |  |  |  |  |
| Mountain Vechernyaya | Republic of Belarus | -67.65 | 46.15 | Seasonal | Yes | Yes | Yes | No | No  (Q13 Yes) |
| Jang Bogo | Republic of Korea | -74.62 | 164.20 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| King Sejong | Republic of Korea | -62.21 | -58.78 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Bellingshausen | Russia | -62.19 | -58.96 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Bunger Oasis | Russia | -66.26 | 100.73 | Seasonal | Yes | Yes | No | No | No |
| Druzhnaya IV | Russia | -69.74 | 73.70 | Seasonal | No |  |  |  |  |
| Leningradskaya | Russia | -69.50 | 159.39 | Seasonal | No |  |  |  |  |
| Mirny | Russia | -66.55 | 93.00 | Year-Round | No |  |  |  |  |
| Molodezhnaya | Russia | -67.66 | 45.84 | Seasonal | Yes | No | No | Yes | No |
| Novolazarevskaya | Russia | -70.77 | 11.83 | Year-Round | Yes | Yes | No | Yes | Yes |
| Progress | Russia | -69.37 | 76.38 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Russkaya | Russia | -74.76 | -136.80 | Seasonal | No |  |  |  |  |
| Vostok | Russia | -78.46 | 106.83 | Year-Round | No |  |  |  |  |
| SANAE IV | South Africa | -71.67 | -2.84 | Year-Round | Yes | Yes | No | Yes | Yes |
| Gabriel de Castilla Station | Spain | -62.97 | -60.67 | Seasonal | Yes | Yes | Yes | Yes | No |
| Juan Carlos I Station | Spain | -62.66 | -60.38 | Seasonal | Yes | Yes | No | Yes | Yes |
| Wasa | Sweden | -73.04 | -13.41 | Seasonal | No |  |  |  |  |
| Vernadsky | Ukraine | -65.24 | -64.25 | Year-Round | No |  |  |  |  |
| Halley VI | United Kingdom | -75.57 | -25.47 | Seasonal | No |  |  |  |  |
| Rothera Research Station | United Kingdom | -67.56 | -68.12 | Year-Round | Yes | Yes | Yes | Yes | No |
| Signy Station | United Kingdom | -60.70 | -45.59 | Seasonal | No |  |  |  |  |
| Amundsen-Scott South Pole Station | United States | -89.99 | 139.27 | Year-Round | No |  |  |  |  |
| McMurdo Station | United States | -77.84 | 166.66 | Year-Round | Yes | Yes | Yes | Yes | Yes |
| Palmer Station | United States | -64.77 | -64.05 | Year-Round | Yes | Yes | No | No | No |
| Artigas Station | Uruguay | -62.18 | -58.90 | Year-Round | Yes | Yes | Yes | No | No |
| Ruperto Elichiribehety Station | Uruguay | -63.40 | -56.99 | Seasonal | Yes | No | Yes | No | No |
| Total affirmative |  |  |  |  | 46/67  (69%) | 43/46 (93%) | 36/46 (78%) | 37/46  (80%) | 30/46 (65%) & with  Q13 31/46 (67%) |

1. Gröndahl, F., Sidenmark, J. & Thomsen, A. (2009). *Survey of waste disposal practices at Antarctic research stations*, Polar Research, 28, pp. 298–306. doi:10.1111/j.1751-8369.2008.00056.x [↑](#footnote-ref-1)
2. Ibidem [↑](#footnote-ref-2)
3. Ibidem [↑](#footnote-ref-3)