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UNIFIED FACILITIES CRITERIA (UFC)

DOMESTIC WASTEWATER TREATMENT

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UNIFIED FACILITIES CRITERIA (UFC)

DOMESTIC WASTEWATER TREATMENT

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER CENTER

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	**Date**	**Location**
1	1 Jan, 2019	1. Updated references in various paragraphs, Appendix B and Appendix C. 2. Updated WEF MOP FD-5 to ASCE MOP 60 a joint publication. 3. Revised paragraphs 3-1.2, 4-3.3 and 5-3. 4. Revised Table 3.1. 5. Added table 3.2 for minimum peak factors.

This UFC supersedes UFC 3-240-02N, dated 16 January 2004 and UFC 3-240-09FA, dated 16 January 2004.

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD (AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Center for Engineering and the Environment (AFCEE) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request. The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site http://dod.wbdg.org/.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

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UNIFIED FACILITIES CRITERIA (UFC)
NEW SUMMARY SHEET

Title: UFC 3-240-02, *Domestic Wastewater Treatment*

Superseding: UFC 3-240-02N, dated 16 January 2004 and UFC 3-240-09FA.

Description: This new UFC 3-240-02 consolidates into one Tri-Service document the civil engineering criteria applicable to wastewater treatment that were formerly in the superseded documents. This UFC – through succinct reference to industry and government standards, codes and references – makes possible the replacement and/or consolidation of numerous criteria documents.

The complete list of wastewater engineering documents referenced in this UFC can be found in Appendices B and C.

Reasons for Document:

- The new UFC updates the guidance and requirements for wastewater treatment contained in several existing engineering documents and efficiently consolidates them into a single UFC.

- The superseded UFC documents included requirements that were not consistent with industry standards or utilized different industry standards.

Impact:

This unification effort will result in the more effective use of DoD funds in the following ways:

- By significantly improving the design process for DoD projects and facilities, through a more efficient application of facilities criteria and enabling more efficient maintenance of facilities criteria.

- The consolidation of the UFC 3-240-02 will positively impact the project costs incurred, as a result of the following direct benefits:

    - Reduction in the number of civil references used for military construction provides more clear and efficient guidance for the design and construction of DoD facilities.

    - Improved clarity and convenience results in reduced time required for execution of project designs.

    - Reduction in ambiguity and the need for interpretation reduces the potential for design and construction conflicts.

    - The reduction in the number of documents and the use of industry standards improves the ease of updating and revising this reference document as better information becomes available.

Non Unified Issues: No major unification issues.

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CHAPTER 1 INTRODUCTION

1-1 PURPOSE AND SCOPE.

This Unified Facilities Criteria (UFC) provides requirements for typical wastewater treatment systems for the Department of Defense (DoD). These minimum technical requirements are based on UFC 1-200-01. Where other statutory or regulatory requirements are referenced in the contract, the more stringent requirement must be met.

1-2 APPLICABILITY.

This UFC applies to service elements and contractors involved in the planning, design and construction of DoD facilities worldwide. It is applicable to all methods of project delivery and levels of construction, but is not applicable to public-private ventures (PPV).

1-3 OTHER CRITERIA

All design and construction outside of the United States and United States territories is governed by international agreements, such as the Status of Forces Agreements (SOFA), Host Nation-Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA), and country-specific Final Environmental Governing Standards (FGS) or \1\ DoD 4715.05-G *Overseas Environmental Baseline Guidance Document* (OEBGD*)* /1/*.* The OEBGD applies when there are no FGSs in place. Therefore, in foreign countries this UFC will be used for DoD projects to the extent that it is allowed by and does not conflict with the applicable international agreements and the applicable FGS or OEBGD.\1\/1/

1-3.1 General Building Requirements.

UFC 1-200-01 provides applicability of model building codes and government-unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, sustainability, low impact development (LID) and safety. Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced therein.

1-3.2 Safety.

All DoD facilities must comply with DODINST 6055.1 and applicable Occupational Safety and Health Administration (OSHA) safety and health standards.

1-3.3 Antiterrorism and Security.

Use and consider installation wastewater vulnerability assessments if available.

1-4 GLOSSARY.

Appendix A contains a glossary of terms used in this document.

1-5 REFERENCES.

Appendix B contains a list of references used in this document. The publication date of the code or standard is not included in this document. In general, the latest available issuance of the reference is used.

1-6 BEST PRACTICES.

Appendix C identifies background information and practices for accomplishing certain wastewater treatment design and engineering services. The Designer of Record (DoR) is expected to review and interpret this guidance as it conforms to criteria and contract requirements, and apply the information according to the needs of the project. If a Best Practices document has guidelines or requirements that differ from the Unified Facilities Guide Specifications (UFGS) or UFC, the UFGS and the UFC must prevail. If a Best Practices document has guidelines or requirements that are not discussed in the Unified Facilities Guide specification (UFGS) or UFC, the DoR must submit a list of the guidelines or requirements being used for the project with sufficient documentation to the Government Project Manager for review and approval prior to completing design.

CHAPTER 2 GENERAL

2-1 DESIGN.

2-1.1 Design Criteria.

Design wastewater treatment systems to meet effluent and stream standards of applicable federal, state and local government agencies or overseas equivalent.

The National Pollutant Discharge Elimination System (NPDES) permit requirements established by the Environmental Protection Agency (EPA) Regional Office and/or State Water Pollution Control authorities typically serve as the effluent standards for a wastewater treatment facility.

Design the wastewater treatment system in accordance with the following criteria precedence:

1. State sewerage regulations for the project location, including State-approved products and treatment systems; consider the regulatory statement of basis for the last NPDES permit renewal if available;

2. Utility provider’s requirements;

3. *Recommended Standards for Wastewater Facilities*, latest edition, Policies for the Review and Approval of Plans and Specifications for Wastewater Collection and Treatment Facilities, A Report of the Wastewater committee of the Great Lakes – Upper Mississippi River Board of State Public Health and Environmental Managers (known hereafter as the “Ten State Standards”), latest edition;

4. \1\ IPSDC /1/, edition corresponding to IBC Building Code edition referenced in UFC 1-200-01.

Exceptions or additions to the above criteria are noted herein. Refer to the applicable Manuals of Practice (MOPs) prepared by the Water Environment Federation (WEF) for additional design criteria, not indicated above, as applicable to the project.

Particularly applicable to the military is the prohibition of release of chemical or biological warfare materials and high-level radioactive wastes.

\1\ /1/

Proposed wastewater facilities and their improvements must conform to applicable zoning requirements, base planning documents and Occupational and Health Administration (OSHA) requirements.

Use the following \1\ Best Practices documents for design guidance:

- ASCE MOP 60,

- WEF MOP 8

- WEF MOP 28 /1/

- Metcalf & Eddy's *Wastewater Engineering: Treatment and Reuse*.

2-1.2 Design Approval.

The Designer of Record must identify and obtain all permits required by federal, state, and local regulatory agencies or overseas equivalent. The Civil Engineering Designer of Record must be a Professional Civil Engineer experienced and licensed; licensure in the location of the project may be required to obtain permits and approvals. Typical permits include permits to construct or modify a Federally Owned Treatment Works (FOTWs), discharge of treated effluent, discharge of stormwater runoff, residual solids management, and operation of FOTWs.

In CONUS locations the Government will review for acceptability plans for new wastewater treatment systems or rehabilitation/replacement of existing wastewater treatment systems. In OCONUS locations with Host nation agreements, follow design approval procedure as directed in project scope and by Government Project Manager. In OCONUS locations without Host nation agreements, the Government will review and approve plans for new wastewater treatment systems or rehabilitation/replacement of existing wastewater treatment systems.

2-1.3 Planning for Non-War Emergencies.

Refer to Best Practices document, AWWA M19, *Emergency Planning for Water Utility Management*, for non-war emergencies such as earthquakes, hurricanes, tornadoes, floods and vandalism.

CHAPTER 3 WASTEWATER SOURCES AND FLOWS

Wastewater flow to a treatment system is based on flow from the following sources: domestic, infiltration, inflow and industrial. Domestic flow is typically based on population.

3-1 DESIGN POPULATION.

Treatment capacity is based on the design population. The design population is determined by the resident and non-resident populations. If the service area for the military installation is strictly residential, the design population must be based on full occupancy of all housing and quarters served. If the area is entirely industrial, the design population is the greatest number, military and civilian, employed in the area at any time, even though some of these persons may also be included in the design of sewers in the residential area. For areas serving both residential and industrial areas, the design population includes residents and nonresidents, but in the design no person must be counted more than once.

The resident population is determined by adding the following:

3-1.1 Military Personnel.

The sum of existing and proposed (programmed) family housing units; permanent, temporary and proposed BOQ and BEQ spaces.

3-1.2 Dependents and Others.

The sum of family housing units times 3.6 \1\residents per unit/1/; the number of National Guard, ROTC and Reserve personnel peak populations normally expected (not in the field); population of any boarding schools; anticipated overnight visitors such as temporary duty (TDY) personnel; guesthouse spaces; any satellite functions such as service to a local community or other Federal bodies; and others not indicated above.

The non-resident population is found by summarizing the following:

- Off-post military (this is the difference between the resident military as indicated in 3-1.1 above and the strength shown in the Installation’s planning documents).
- Civilian personnel under civil service
- Contractor personnel
- Daytime schools
- Daytime transients

The effects of birth rates, death rates, and immigration are not applicable to military installations. The assigned military populations both present and foreseeable, is obtained from the Installation’s planning documents.

3-1.3 Capacity Considerations.

Consider design population for next five (5) years according to Installation's planning documents; design with some reserve capacity. Consider seasonal fluctuations; low flow/loading conditions; and impacts to flow from industrial sources and ship to shore. Consider need for future expansion in layout of proposed treatment components and processes so that a reasonable footprint for expansion can be accommodated.

When designing for the expected five (5) year growth, new pipeline designs must account for minimum and typical velocities as indicated in UFC 3-240-01 and UFC 3-230-01. This will ensure that if additional growth does occur, the system will be able to continue to operate within acceptable velocity ranges.

3-2 WASTEWATER FLOWS.

3-2.1 Domestic Wastewater Flows.

Actual annual wastewater flow and load data must be used to determine wastewater design flows. In the absence of actual wastewater flow and load data, actual annual water consumption data for a facility must be used to determine wastewater design flows. If actual water consumption data are not available that meet requirements of state regulations, base wastewater design flows on average daily per capita wastewater quantities for the types of facilities included in the state regulations or overseas equivalent. In locations where state regulations or overseas equivalent do not address types of facilities, obtain typical waste loading values from Table 3.1.

Other buildings and establishments normally found on military installations must be assigned typical waste loading values obtained from the latest edition of Best Practices document, Metcalf & Eddy's *Wastewater Engineering: Treatment and Reuse*. Do not use these typical waste loading values for contingency operations.

3-2.1.1 Average Daily Flow.

When designing sewers to serve the entire military installation, or large areas of the installation, and where a major portion of the wastewater is generated by residents over a 24-hour period, the average daily flow will be used and determined as follows:

Average Daily Flow = Design Population x Per Capita Rates

Table 3.1: Domestic Wastewater Allowances[1]

Type of Installation or Building[2]	Permanent	Field
\1\ Per Capita /1/	**gal/cap/day (m^3/cap/s)**	**gal/cap/day (m^3/cap/s)**
Military Installations[2]	100 (4.38 x 10^{-6})	35 (1.5 x 10^{-6})
Nonresident Personnel and Civilian Employees (per 8 hr. shift)	30 (1. x 10^{-6})3	
Military Training Camps		50 (2.2 x 10^{-6})
BOQ and BEQ [2]	70 (3.1 x 10^{-6})	20 (8.8 x 10^{-7})
Barracks [2]	50 (2.2 x 10^{-6})	15 (6.6 x 10^{-7})
\1\ Per Unit /1/	**\1\ gal/unit/day (m^3/unit/s) /1/**	
Single Family Housing [2,3]	300 (1.31 x 10^{-5})	
Multi Family Housing [2,3]	250 (1.10 x 10^{-5})	

1. Allowances do not include industrial or process wastes.
2. These values represent domestic waste quantities for resident personnel averaged over the entire installation for a 24-hour period.
3. In family housing areas, each housing unit must be assigned 3.6 residents for the purpose of calculating populations.

3-2.1.2 Average Hourly Flow.

When designing wastewater systems serving small areas of a military installation and where the majority of wastewater is generated by nonresidents or other short term occupants, use the average hourly flow rate (versus the average daily flow) which is based on the actual period of waste generation. For example, 1000 nonresidents at 30 gal/cap/day (1.3 x 10^{-6} m^3/cap/s) will generate 30,000 gallons (114 m^3) in 8 hours for an average hourly flow rate of 3750 gal/hr (3.94 x 10^{-3} m^3/s). Note that the average daily flow is still 30,000 gal/day (1.31 x 10^{-3} m^3/s), but the wastewater system must be designed to carry the 30,000 gallons (114 m^3) in 8 hours not 24 hours.

3-2.1.3 Peak Flow.

The peak flow must be based on the average daily flow or average hourly flow (as indicated above) increased by the appropriate peaking factor. \1\ Use Table 3.2 to for peaking factors:

Table 3.2: Minimum Peak Flow Factors

Population	Peak Factor
Greater than 500,000	2.5
Between 100,000 and 500,000	3.0
Less than 100,000	4.0

/1/ For wastewater collection system components \1\outside of the five foot line, consider peak wastewater flow determined by the total drainage fixture units in accordance with UFC 3-420-01 and ASCE MOP 60 Chapter 3, titled *Quantity of Wastewater*. Peak wastewater flow determined by total drainage fixture units may be used /1/ in lieu of peak wastewater flow based on population if it is determined to be higher.

3-2.1.4 Cold/Arctic Locations.

Wastewater systems in arctic locations practice water conservation. Water consumption is typically low and infiltration is nil. If actual water consumption data are not available, base average daily wastewater flow for cold/arctic locations on 80% of the flow determined for similar uses.

3-2.1.5 Water Conservation Devices.

Consider water conservation devices reduce water consumption; however it is highly dependent on the particular fixture or appliance selected.

3-2.2 Industrial Wastewater Flows.

Industrial waste sewers and sanitary sewers must be designed for the peak industrial flow as determined for the particular industrial process or activity involved.

Industrial wastewater flows will be minimal at most military installations. When industrial flows are present, however, actual measurement is the best way to ascertain flow rates. Modes of occurrence (continuous or intermittent) and period of discharge must be known.

Typical industrial discharges include wastewaters from the following:

- Wastewater treatment plant itself
- Maintenance facilities
- Vehicle wash areas
- Weapons cleaning buildings
- Boiler blowdowns
- Swimming pool backwash water
- Water treatment plant backwash
- Cooling tower blowdown
- Firefighting facility
- Medical or dental laboratories.

3-2.2.1 Ship Holding Tank Discharges.

Ship holding tank discharges can be a major source of wastewater at military installations with naval facilities. These wastewaters typically have the following general characteristics:

- Primarily domestic wastewater but may also contain industrial wastewater depending on ship operations;
- More concentrated than typical domestic wastewater due to wastewater collection system design on ships;
- May contain high concentrations of dissolved solids, chloride, sulfates, and sodium if seawater flushing of ballast systems is used.

Provide wastewater collection, treatment, and transmission systems for piers, wharfs, and drydock facilities in accordance with UFC 4-150-02.

3-3 DESIGN FLOWS.

The design of process elements in a wastewater treatment plant is based on the actual average wastewater hourly flow and the hydraulic components (pumps, pipes, etc.) are based on the peak hourly flow. Clarifiers must be designed for a peak hourly flow rate.

Consider infiltration and inflow and industrial flows. Typical peaking factors consider normal infiltration for systems built with modern construction techniques. However, an additional allowance for infiltration and inflow must be added where conditions are unfavorable.

Consider low flow/loading conditions in the design of process elements, components and accessories.

3-4 WASTEWATER CHARACTERISTICS.

The waste stream to be treated at existing military installations must be characterized; this actual data must be used in the design. Analytical methods will be as given in the current edition of American Public Health Association (APHA) publication, *Standards Methods for the Examination of Water and Wastewater.*

3-4.1 Ship Holding Tank Discharges.

A wastewater characterization analysis must be conducted on ship holding tank discharges for the proposed dockside collection, treatment, and transmission prior to selection of materials or treatment process for the proposed wastewater system. A complete chemical analysis of the typical wastewater discharge, must include, but is not limited to, Total Organic Carbon, 5-day Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Nitrate-Nitrogen (NO_3-N), Ammonia-Nitrogen (NH_3-N), Total Kjeldahl Nitrogen (TKN), pH, Chloride, Total Phosphorus, Phenol, Total Volatile Organic Compounds, Fecal Coliform, Calcium, Sodium, Magnesium, Sodium Adsorption Ratio (SAR), Total Trihalomethanes, Toxicity test parameters, and Total Dissolved Solids.

3-5 MATERIALS SELECTION.

\1\ Use UFC 3-240-01 /1/.

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CHAPTER 4 SITE SELECTION

4-1 LOCATION.

In absence of a state or Host Nation requirement, a minimum distance of 1,000 feet (305 m) must be maintained between drinking water source and any proposed wastewater treatment system.

For onsite wastewater treatment systems, rainfall and soil characteristics are major criteria.

Plants of 50,000 gallons per day (2.19 x 10^{-3} m^3/cap/s) or less treatment capacity must be more than 500 feet (152 m) from living quarters, working areas and public use areas, when this minimum distance will not result in unacceptable noise or odor levels. Larger plants, and wastewater treatment ponds regardless of size, must be more than one-quarter mile from such facilities. Greater distance may be required when such facilities are located: on the leeward side of the treatment plant; in areas subject to prolonged or frequent air stagnation or fog/mist cover; and at a lower elevation than the treatment works, with surface and groundwater flow from the treatment plant toward the occupied area.

4-1.1 Flood Elevations.

Clarification on State regulations and *Ten State Standards*: 25 year and 100 year flood elevations must be determined according to UFC 3-201-01.

A minimum of 2 feet (600 mm) protection from a 100 year flood must be provided unless there is a water-tight seal on all station hatches and manholes with control panels and vents extending 2 feet (600 mm) above the 100 year flood elevation.

4-1.2 Cold/Arctic Locations.

Exceptions to the 500 feet (152 m) restriction above can be made for cold climate module complexes where the treatment system is a part of the module complex. However, sewage treatment works must not be located within the same module as living quarters.

4-1.3 Onsite Wastewater Treatment Systems.

Onsite wastewater treatment systems, such as standard septic tanks with subsurface drain fields, do not fall under the 500 feet (152 m) restriction. In cases where special design is provided to control aerosols, gases and odors, a waiver to reduce the minimum distance may be requested and approved by the Government. Distance reductions must not result in creation of unacceptable noise levels when plant equipment is in operation. The request must state the special design features that support the waiver, including any pertinent supporting data. Unit processes, plant size, and prevailing wind and climatic conditions must be given. In addition, the elevation differentials in relation to prevailing winds, adjacent facilities and terrain must be described.

4-2 ACCESS.

The site must be selected so that an all-weather road is available or can be provided for access to the plant. Consideration must be given, during layout of buildings, roads, fencing and appurtenances, to winter conditions, especially of snow drifting and removal.

4-3 FIELD INVESTIGATION.

4-3.1 Existing and Proposed Service Areas.

Utilize Installation's existing utility maps and proposed planning documents to develop existing and proposed service areas for present and future (minimum 5 year) conditions.

4-3.2 Topographic Survey.

Provide a topographic survey of project area including locations of existing utilities in accordance with UFC 3-201-01. \1\

4-3.3 Geotechnical Site Investigation – Soil Corrosivity.

Use UFC 3-240-01. /1/

4-3.4 Environmental Considerations.

Contact the Installation's Environmental Reviewer prior to design and evaluate site for environmental concerns and known contamination. Notify Government Project Manager of known environmental contamination to ensure adequate funding in current project.

CHAPTER 5 TREATMENT PROCESS SELECTION

Treatment processes are selected according to influent-effluent constraints and technical and economic considerations.

5-1 FACTORS.

The design of treatment facilities must be determined by feasibility studies, considering all engineering, economic, energy and environmental factors. All legitimate alternatives must be identified and evaluated by life cycle cost analyses.

According to Section 313 (b) (2) of PL 95-217, construction must not be initiated for facilities for treatment of wastewater at a federal property or facility if alternative methods of wastewater treatment at some similar property or facility utilizing innovative treatment processes and techniques, including but not limited to methods utilizing recycle and reuse techniques and land treatment, are in use. If the life-cycle cost of the alternative treatment works exceeds the life-cycle cost of the most cost effective alternative by more than 15 percent, then the least expensive system must be used. The appropriate Government authority may waive the application of this paragraph in any case when the appropriate Government authority determines it to be in the public's interest, or that compliance with this paragraph would interfere with orderly compliance with conditions of a permit issued pursuant to section 402 of this act.

Request for waiver of the above requirement, with supporting justification, must be forwarded for review and approval by the appropriate Government authority.

5-2 PRELIMINARY TREATMENT.

Preliminary treatment of wastewater includes screening, grinding, grit removal, flotation, equalization, and flocculation. Pre-aeration may be required to prevent odor problems and to eliminate septic conditions where wastewater has abnormally long runs to the plant. Consider corrosion protection from hydrogen sulfide release in pretreatment structures, including wet wells and basins.

5-2.1 Flow Equalization.

Flow equalization of at least 25 percent of the facility's peak hydraulic capacity must be provided for all seasonal facilities and all other facilities with fluctuations in influent flow which may adversely affect the performance of the wastewater treatment system.

5-3 PRETREATMENT.

\1\ Most treatment facilities are not designed to treat industrial wastes that may contain toxic or non-conventional pollutants. Where pollution prevention techniques such as reducing, reusing or recycling nondomestic waste are not sufficient to reduce pollutants such as primary or toxic pollutants, provide pretreatment for nondomestic wastewater sources in accordance with National Pretreatment Program published in 40 CFR Part 403. Document the nondomestic wastewater sources and the pretreatment strategies used for compliance. Wastewater treatment plants must be capable of treating normal laundry wastes together with sanitary wastewater. Pretreatment of normal laundry wastes are not considered except when such wastes might exceed 25 percent of the average daily wastewater flow./1/

5-4 SPECIAL CONSIDERATION FOR THE TROPICS/SEMIARID LOCATIONS OUTSIDE THE UNITED STATES.

For wastewater treatment unit operations in the tropics, the Civil Engineering Designer of Record must examine each unit operation in the proposed treatment system for potential problems caused by high temperature, torrential tropical rain, and local sewage characteristics variations.

5-5 SPECIAL CONSIDERATION FOR THE COLD/ARCTIC LOCATIONS OUTSIDE THE UNITED STATES.

For wastewater treatment unit operations in cold/arctic climates, the Civil Engineering Designer of Record must examine each unit operation in the proposed treatment system for potential problems and costs caused by extreme cold, wind and snow, remote locations, thermal stress on structures, frost heaving, permafrost, and limited availability of construction materials, labor and time for construction and/or maintenance.

CHAPTER 6 ONSITE WASTEWATER TREATMENT SYSTEMS

6-1 GENERAL.

Conventional onsite wastewater treatment system consists of a septic tank system with a tank, distribution box and nitrification lines in a drain field. Components can include effluent filter(s), dosing pump(s), pump tank(s) and pressure manifold. Some soil conditions require an alternate drain field location.

Alternative onsite wastewater treatment systems include a low-pressure pipe system with a septic tank (or other state or Host Nation approved pretreatment system) and a pumping tank. Other state or Host Nation approved treatment systems may include aerobic treatment units (ATU), recirculating sand filters, and peat biofilters. Non-ground absorption sewage treatment systems, such as waterless toilets, may also be used in particular applications as described in this chapter.

6-2 TYPICAL MILITARY APPLICATIONS.

Remote training locations where connection to a wastewater collection system is impossible or impracticable can be served well by onsite wastewater treatment systems.

6-3 SEPTIC TANK SYSTEMS.

Septic tank systems must be designed based on the criteria precedence indicated in paragraph 2-1.1 entitled "*Design Criteria*". Additional, alternative pretreatment units may be required to meet stricter effluent standards. Grease, nonbiodegradable products and industrial wastewater must not be discharged into these systems. For this reason garbage grinders are not allowed in septic tanks systems.

Exception to \1\ IPSDC /1/: Septic tanks must only be constructed of concrete, fiberglass or polyethylene.

6-4 ALTERNATIVE ONSITE WASTEWATER TREATMENT SYSTEMS.

Utilization of innovative wastewater systems, technologies, components, or devices is encouraged provided that the manufacturer has obtained approval for commercial use in the State or Host Nation where the project is located by the appropriate permitting agency.

If the Civil Engineering Designer of Record utilizes a particular wastewater treatment system, technology, component or device, more than one manufacturer must be listed in the construction documents in accordance with current FAR regulations. The manufacturers' systems or components indicated must be currently approved for commercial use for the proposed application and project conditions in the State or Host Nation where the project is located. If the State or Host Nation does not maintain an approved wastewater treatment system or components list or the project is in a location not subject to state sewerage regulations, then documentation must be provided to the Government indicating that each manufacturer's proposed wastewater system or component is approved in at least one other state or Host Nation for commercial use for a similar application.

6-5 NON-GROUND ABSORPTION SEWAGE TREATMENT SYSTEMS.

Where a septic tank or a connection to a wastewater collection system is impossible or impractical, non-ground absorption treatment systems utilizing heat or other approved means for reducing the toilet contents to an inert or stabilized residue or to an otherwise harmless condition may be used.

Waterless toilets include composting toilets, incinerating toilets, mechanical toilets, vault privies and aerated pit latrines. Chemical or portable toilets are also waterless toilets that must have a watertight waste receptacle constructed of nonabsorbent, acid resistant, noncorrosive material.

When used in a facility that cannot have any connection to a water supply source, handwashing facilities must be provided by waterless bacteriological hand cleaner and disposable hand towels or pre-moistened hand towels, and drinking water must be provided by bottled water. No water supply connection may be used for hand cleaning purposes or for drinking unless there is a sewage treatment and disposal system.

CHAPTER 7 SMALL TREATMENT SYSTEMS

7-1 GENERAL.

Wastewater treatment systems less than 0.5 million gallons per day (2.19 x 10^{-2} m3/s) are considered small treatment systems. Small treatment systems and components must be designed based on the criteria precedence indicated in paragraph 2-1.1 entitled "*Design Criteria*".

If the Civil Engineering Designer of Record utilizes a particular wastewater treatment system, technology, component or device, more than one manufacturer must be listed in the construction documents in accordance with the latest FAR regulations. The manufacturers' systems or components indicated must be currently approved for commercial use for the proposed application and project conditions in the State where the project is located or overseas equivalent. If the State or overseas equivalent does not maintain an approved wastewater treatment system or components list or the project is in a location not subject to sewerage regulations, then documentation must be provided to the Government indicating that each manufacturer's proposed wastewater system or component is approved in at least one other state or overseas equivalent for commercial use for a similar application.

7-2 TYPICAL MILITARY APPLICATIONS.

Most small treatment systems on military installations are packaged treatment plants.

7-3 PACKAGED TREATMENT PLANTS.

These systems combine processes such as aeration, settling, and solids treatment in a single multicompartment tank. Typical types include extended aeration (activated sludge), complete mix (activated sludge), step aeration (activated sludge), contact stabilization (activated sludge), biofiltration, rotating biological contactors (RBC), sequencing batch reactors (SBR). Various processes may include proprietary components; the Civil Engineering Designer of Record needs to specify performance requirements or obtain specific documentation (D&F) from the Government's Project Manager prior to inclusion in contract documents.

7-4 WASTEWATER TREATMENT PONDS/LAGOONS.

Wastewater treatment pond systems include flow-through facultative (aerobic-anaerobic); controlled-discharge facultative; and aerated.

All treatment/storage lagoons/ponds must have at least two feet of freeboard.

Treatment systems utilizing earthen basins, lagoons, ponds or trenches, excluding holding ponds containing non-industrial treated effluent prior to spray irrigation, for treatment, storage or disposal must have either a liner of natural material at least one foot in thickness and having a hydraulic conductivity of not greater than 1 x 10^{-6} centimeters per second when compacted, or a synthetic liner of sufficient thickness to exhibit structural integrity and an effective hydraulic conductivity no greater than that of the natural material liner.

7-5 DISINFECTION.

Disinfection of the effluent must be provided as necessary to meet applicable effluent standards.

Chlorine gas must not be used for disinfection for a small wastewater treatment system.

7-6 CHEMICAL STORAGE AND HANDLING CONSIDERATIONS.

WEF MOPs, chemical manufacturers and industrial associations provide guidance on designing dry and liquid, chemical feed systems for wastewater treatment operations. Report any hazardous chemicals used on a project to Base Environmental.

7-6.1 Chemical Handling.

Include the following in a chemical handling area, as applicable:

- Easily accessible, clearly marked, well lighted unloading stations;
- Guard posts to protect equipment and storage tanks from vehicle damage;
- A roofed platform or dock for unloading containerized chemicals;
- Mechanical devices to aid unloading and transporting chemicals to storage areas;
- Separate receiving and storage areas for chemicals that react violently when mixed together;
- Unique pipe configuration and valving for each chemical storage tank on site to prevent the wrong chemical from being loaded into a tank;
- Dust control equipment for dry bulk and bagged chemicals;
- Protection of concrete against corrosive chemicals;
- Washdown and cleanup facilities for all chemical handling areas and separate drainage systems for noncompatible chemicals;
- A bulk tank level control system with a high-level alarm audible at the truck unloading station.

7-6.2 Chemical Storage.

7-6.2.1 Storage for all Chemicals.

Provide the following:

- Provide adequate storage for peak demands;
- Label chemical storage areas;
- Determine compatibility of all chemicals stored;
- Store incompatible chemicals separately;

- Follow the chemical manufacturer's recommendations with regard to material compatibility and selection of system components in direct chemical contact;
- Comply with all applicable codes and regulations;
- Locate light and ventilation switches outside storage areas;
- Provide automatic controls to actuate forced ventilation and lighting when chemical storage rooms are occupied;
- Protect concrete and other exposed materials against corrosive chemicals.

7-6.2.2 Storage for Dry or Containerized Chemicals.

Provide the following:

- Store materials in original containers in dry rooms on boards or pallets;
- Provide adequate room to maneuver hand trucks, pallet jacks, or forklifts;
- Locate the storage of dry chemicals at feed hopper inlet level, if possible. Alternatively, provide a platform suitable for supporting a pallet of containers at the feed hopper inlet level;
- Post safe-load limits for floors and shelving.

7-6.2.3 Storage for Liquid Chemicals.

Provide the following:

- Provide for containment of store volume plus a safety margin;
- Provide for cleanup or reuse of spilled material;
- Ensure that bulk containers have sufficient capacity to hold the contents of one standard tank truck plus a sufficient reserve supply between shipments;
- Provide approved storage facilities for flammable liquids;
- Provide freeze protection for exposed piping, valves, and bulk tanks.

7-6.3 Feed Equipment.

Consider the following:

- Follow the chemical manufacturer's recommendations with regard to material compatibility and selection of system components in direct chemical contact;
- Equip pump and equipment that handle corrosive solutions with spray or splash guards to protect the personnel working in the area.

7-6.4 Safety.

Ensure adequate safety by providing the following:

- Continuous toxic gas monitors with alarms;
- Explosive gas monitors and alarms, ventilation equipment and other safety devices for flammables such as special grounding measures, flame and spark arresters, etc. to ensure a non-explosive environment is maintained and potential ignition sources are eliminated;
- Self-contained breathing apparatus (SCBA) for emergency gas release situations;
- Emergency deluge shower and eyewash facilities located where easily accessible to those in need; comply with the latest edition of ANSI Z358.1 for emergency eyewashes and shower equipment.
- Adequate ventilation;
- Personal protective apparel such as gloves, goggles, face shields, aprons and dust masks;
- Nonslip flooring in polymer storage and handling areas;
- Facility designs that eliminate the need to reach beyond safe limits;
- Facility designs that minimize the need for manual lifting;
- Directive, hazard-warning, and instructional signs where appropriate.

7-7 EFFLUENT DISPOSAL/RECLAMATION.

Two primary means of effluent disposal and reclamation are surface water discharge and nondischarge wastewater systems.

7-7.1 Surface Water Discharge Outfalls.

7-7.1.1 Outfall Location.

A waste load allocation study is typically conducted to ensure a surface water discharge does not impair the receiving water quality below the state's water quality standard or overseas equivalent. If a larger water body with more dilution capability is nearby, then it may be necessary to pipe the treatment plant effluent to this larger water.

7-7.1.2 Outfall Configuration.

If a pipe has a simple open end, then better mixing can be attained by installing a diffuser that induces jet flow from one or more ports.

7-7.1.3 Sizing/Capacity.

Design the minimum size of the outfall for peak hour flow at the maximum anticipated stage of the receiving water. If the receiving water is tidal, evaluate both high and low conditions. If a diffuser is installed, use mixing models to select the port sizes and spacing. Direct the ports on diffusers slightly upward so flow does not impinge on the water body bottom. Ensure that port sizes are 2 inches (50 mm) in diameter or greater to ensure that the ports will not be clogged by scaling or barnacles.

7-7.1.4 Outfall Depth.

Consider extending an outfall to deeper water if an existing outfall is in shallow water, is having permit compliance issues, and can be extended. Outfalls typically need to be at least 8 feet (2.4 m) deep to provide mixing opportunity.

7-7.1.5 Outfall Protection.

Anchor outfall pipelines in place in the receiving water to prevent movement. Anchoring is often accomplished by burying the pipeline and using a 90 degree elbow at the end to surface the outfall. Multiport outfalls may have risers along the pipeline extending above the buried pipeline. Piers can be used to support the outfall for some of the distance from shore, but the pipeline extending beyond the pier needs anchoring. Sometimes pipes have collar-type concrete weights that can be partially submerged with jets to anchor the pipeline. Sometimes riprap is used to stabilize and provide ballast for the pipeline sitting on the bottom grade.

Consider sedimentation and scour forces on above grade pipelines.

Provide outfall protection per federal, state and local agency requirements having jurisdiction. If the pipeline is too shallow, it can interfere with boat traffic. Some regulatory agencies may allow a shallow outfall if it is marked with lighted warning buoys or by other means. The transition zones near the shoreline need special consideration during design and consideration, since there are the most environmentally sensitive and publicly visible areas.

7-7.2 NonDischarge Wastewater Systems.

Nondischarge systems for groundwater recharge include surface irrigation, high rate infiltration facilities, and injection wells. Nondischarge systems also include aquifer storage recovery. Design of nondischarge wastewater systems must consider local conditions of water quality, climate, soil, hydrogeology and environmental constraints.

7-7.2.1 Surface Irrigation.

Surface irrigation and land application methods include spray irrigation or drip irrigation systems for landscape maintenance or agriculture purposes.

7-7.2.2 High Rate Infiltration Facilities.

Artificial recharge of groundwater can also be achieved with infiltration basins. Design the overall system to allow any basin to be taken out of service for a sufficient drying period.

7-7.2.3 Injection Wells.

Use of injection wells must be considered as a last resort for wastewater treatment and must be approved by Federal, state and/or local regulatory agencies. Potential applicable areas where injection wells may be considered include where sanitary systems are not available; land is limited or too costly; excessive wastewater flows; or in areas with high water tables. Do not install injection wells in close proximity to drinking water sources and to vadose zones that have restricting layers or undesirable chemicals that may leach.

7-7.2.4 Aquifer Storage Recovery.

Government approval is required prior to design.

7-8 RESIDUALS MANAGEMENT.

Biosolids/sludge for small wastewater treatment systems are typically removed and hauled off for disposal by a State-certified or overseas equivalent waste hauler. Biosolids/sludge may be hauled to the Installation’s sludge drying beds in accordance with state regulations and permits or overseas equivalent. For larger wastewater treatment systems, reuse of biosolids for composting or land application may be cost effective. The existing Residuals Management Plan must be reviewed; notify Government PM if updates are needed to accommodate project if not included in scope of work.

CHAPTER 8 INSTRUMENTATION AND CONTROLS

8-1 GENERAL.

Provide for controls and remote monitoring, such as telemetry, in conformance with applicable regulatory and utility provider requirements. Controls and remote monitoring systems must meet the Installation's IT security requirements and standards.

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APPENDIX A GLOSSARY

Arctic: The region north of the Arctic Circle (66^{o} 34’ N), or, loosely, northern regions in general, characterized by very low temperatures.

Tropics: Areas of the Earth within 20 degrees North and South of the Equator.

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APPENDIX B REFERENCES

GOVERNMENT PUBLICATIONS

UNIFIED FACILITIES CRITERIA (UFC), DEPARTMENT OF DEFENSE (DoD) http://dod.wbdg.org/

UFC 1-200-01, \1\ *DoD Building Code (General Building Requirements)* /1/

UFC 3-201-01, *Civil Engineering* \1\/1/

UFC 3-210-10, *Low Impact Development*

UFC 3-230-01, \1\ *Water Storage and Distribution* /1/

UFC 3-240-01, *Wastewater Collection*

\1\ UFC 3-420-01, Plumbing Systems

UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings* /1/

UFC 4-020-01, *DoD Security Engineering Facilities Planning Manual*

UFC 4-150-02, *Dockside Utilities for Ship Service*

DEPARTMENT OF DEFENSE

\1\ DoD 4715.05-G, *Overseas Environmental Baseline Guidance Document,* /1/

DODINST 6055.1, *DoD Safety and Occupational Health (SOH) Program*

NON-GOVERNMENT PUBLICATIONS

AMERICAN PUBLIC HEALTH ASSOCIATION (APHA), 8001 STREET, NW, WASHINGTON, DC 20001 \1\/1/

Standards Methods for the Examination of Water and Wastewater, latest edition

\1\ /1/GREAT LAKES – UPPER MISSISSIPPI RIVER BOARD OF STATE PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS

Recommended Standards for Wastewater Facilities, latest edition

INTERNATIONAL CODE COUNCIL

\1\ IPSDC, *International Private Sewage Disposal Code*, edition corresponding to IBC Building Code referenced in UFC 1-200-01 /1/

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APPENDIX C BEST PRACTICES

This appendix identifies background information and practices for accomplishing certain wastewater design and engineering services. The Civil Engineering Designer of Record (DoR) is expected to review and interpret this guidance and apply the information according to the needs of the project. If a Best Practices document has guidelines or requirements that differ from the UFGS or Unified Facilities Criteria, the UFGS and the UFC must prevail. If a Best Practices document has guidelines or requirements that are not discussed in the Unified Facilities Guide specification (UFGS) or UFC, the DoR must submit a list of the guidelines or requirements being used for the project with sufficient documentation to the Government Project Manager for review and approval prior to completing design.

C-1 WHOLE BUILDING DESIGN GUIDE.

The Whole Building Design Guide provides additional information and discussion on practice and facility design, including a holistic approach to integrated design of facilities.

The WBDG provides access to all Construction Criteria Base (CCB) criteria, standards and codes for the DoD Military Departments, National Aeronautics and Space Administration (NASA), and others. These include, Unified Facilities Criteria (UFC), Unified Facilities Guide Specifications (UFGS), Performance Technical Specifications (PTS), design manuals, and specifications. For approved Government employees, it also provides access to non-government standards.

C-2 WASTEWATER ENGINEERING RELATED GUIDANCE.

GOVERNMENT PUBLICATIONS:

NON-GOVERNMENT PUBLICATIONS:

\1\ AMERICAN SOCIETY OF CIVIL ENGINEERS

1801 Alexander Bell Drive, Reston, VA 20191-4400

https://ascelibrary.org/

ASCE MOP 60, *Gravity Sanitary Sewer Design and Construction*, a joint publication with WEF (WEF MOP FD-5) /1/

AMERICAN WATER WORKS ASSOCIATION, 6666 W. QUINCY AVENUE, DENVER, CO 80235

AWWA Manual M19, *Emergency Planning for Water Utility Management*

\1\ AWWA Manual M27, *External Corrosion – Introduction to Chemistry and Control* /1/

BUTTERWORTH-HEINEMANN, 30 CORPORATE DRIVE, SUITE 400, BURLINGTON, MA 01803

Pumping Station Design, edited by Garr M. Jones with Robert L. Sanks, George Tchobanoglous and Bayard Bosserman, latest edition

CRC PRESS

Wastewater Treatment Plants: Planning, Design, and Operation by Syed R. Qasim, latest edition

THE McGRAW HILL COMPANIES, INC., 1221 AVENUE OF THE AMERICAS, NEW YORK, NY 10020.

Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy, Inc., latest edition.

VAN NOSTRAND REINHOLD

Disinfection Alternatives for Safe Drinking Water by Hazen and Sawyer, latest edition

\1\ WATER ENVIRONMENT FEDERATION, 601 WYTHE STREET, ALEXANDRIA, VA 22314-1994

WEF MOP 8, *Design of Water Resource Recovery Facilities*

WEF MOP 28, *Upgrading and Retrofitting Water and Wastewater Treatment Plants*/1/

C-3 ADDITIONAL BEST PRACTICES.

C-3.1 Onsite Wastewater Treatment Systems.

C-3.1.1 Holding Tanks.

Holding tanks are not typically considered as an acceptable sewage treatment and disposal system.

C-3.2 Treatment Process Selection.

C-3.2.1 Special Consideration for the Tropics/Semiarid Locations Outside the United States.

Consider that brackish water may be used for washing, cooling, or cleaning; if it is allowed to enter the waste stream, the increased salinity will lower biological process efficiencies. Also high dissolved solids concentrations have an impact on the treatment process efficiency. If grey water is separated from the waste stream and recycled or used directly for irrigation, washing or cooling, wastewater flow will be low and much more concentrated. Loss of water by evaporation and from pipelines into the ground may further decrease flow to the wastewater treatment plant.

C-3.2.1.1 High Temperature Parameters.

A major design parameter will be water temperature. Use of rooftop rain storage, cistern water, brackish water, and the ambient conditions will result in a very warm sewage. The engineer must expect high salt content, including sulfate, chloride, phosphate, borate and nitrate ions, and both alkali and alkaline earth cations. Oxygen levels will be very low and chalcogenides as well as dissolved hydrogen sulfide must be anticipated. The most dramatic effect of high temperature will be upon biochemical reaction rates.

C-3.2.1.2 Unit Operations in the Tropics.

Although activated sludge, trickling filter or rotating biological filter processes may be used in hot climates, strong sunlight and adequate space will make the use of wastewater treatment ponds advantageous. Temperature and sunlight intensity will control algal growth, which will be intense. The most useful type of pond will be the facultative pond. Pond retention time may be over 30 days; depth is usually between 5 and 10 feet (1.5 and 3.0 m).

Not only are photosynthetic and microbiological processes accelerated, but gas formation is also increased as temperature rises. Sludge rising is often a problem since sludge accumulates at a rapid rate and much gas is evolved in the material. More frequent desludging may be required than normal to ensure that sludge age is in the appropriate range. Settlement rate is controlled by viscosity so that the temperature increase does not dramatically change retention time in primaries, which is usually 1-2 hours in a correctly design tank.

The effect of increased temperature reduces the saturation concentration of oxygen in any process, such as a trickling filter or packaged activated sludge plant, but, fortunately, the mass transport coefficient is increased. In any system involving plug flow, initial oxygen demands will be very high. Flow to the plant will usually be anaerobic. The engineer, must, therefore, anticipate 5 to 15 percent larger blower or bubbler air demands than required in the United States. At high altitudes, the oxygen saturation value will again be reduced, requiring further increased air capacity at about 5 percent per 1000 feet (305 m). Dissolved oxygen monitoring, such as with electrodes, must be mandatory in hot climate wastewater treatment plant processes because both under and over-aeration will result in process disturbance. In package treatment plants where gravity return of settled activated sludge is common, the sludge will usually turn anaerobic, making positive sludge return usually advisable. Aerobic stabilization of activated sludge is most applicable in hot climates.

For trickling filters and rotating biological disc filters, filter media volumes decrease proportional to temperature increases.

Sludges dry much more rapidly in hot climates; but in the humid tropics, covers must be required. Odor problems have been common in the sludges produced in hot climates, indicating that aerobic digestion or aerobic composting are potentially useful.

Investigate anaerobic digestion and gas production since a hot climate encourages microbiological fermentation reactions.

C-3.2.2 Special Consideration for the Cold/Arctic Locations Outside the United States.

Extreme low temperature is common: as low as -75 degrees Fahrenheit (-59 degrees Celsius) in interior locations in northern Canada; below -100 degrees Fahrenheit (-73 degrees Celsius) in Antarctica; and a month or more of sub-zero air temperature in the Arctic. Water, sewer, electric utilities and steam lines are typically run in utilidors above ground to conserve their heat, allow easy access and conserve materials. Utilidors are kept insulated from the ground because the permafrost can be alternately melted and frozen if trenches are used.

C-3.2.2.1 Wind Protection.

Wind in the arctic zone produces a great heat loss problem which is reflected in wind chill factors. Snow and wind loads on structures require careful consideration. Precipitation in northern climates is typically quite low, but the snow produces drifts and can cause severe problems in transportation and operation if the engineer fails to consider wind. Rotating biological equipment and other covered equipment must not only be well insulated, but must also be designed to withstand thermal extremes, buffeting wind loads and wet spring snow.

C-3.2.2.2 Conservation Practices.

In general on military installations in arctic locations, water conservation is practiced. The wastewater from these bases is high strength since water consumption is normally low; infiltration is nil; and stormwater is excluded. Since wastewater is transported above the ground surface or in well-insulated, well-constructed tunnels, fresh water use is almost the same as wastewater return. Design conditions can be expected to be about 300 parts per million, ppm (300 mg/L) for Biochemical Oxygen Demand, 5 day (BOD_5) at 60 to 80 gal/cap/day (2.63×10^{-6} to 3.51 s 10^{-6} to 0.30 m^3/cap/s). Wastewater will typically be delivered to the plant at around 50 degrees Fahrenheit (10 degrees Celsius).

C-3.2.2.3 Processes.

Chemical and biological processes are negatively affected by extreme cold. Chemical reaction rates are generally slower at low temperatures, and chemical solubilities are reduced. All chemical reactions, especially those involving partially soluble salts, must be recalculated to reflect the low solubility of chemicals in cold water. Each flocculent or deflocculent, each polymer and each detergent or other organic chemical used must be tested for unanticipated interaction brought about by low temperatures.

The rates of biological reactions are also reduced greatly, which affects the sizing of biological treatment processes. The biological processes that have been used most successfully in cold climates include wastewater treatment ponds, either facultative or aerated; activated sludge with long solids retention times; and attached growth systems. Design biological processes such as lagoons and ponds to withstand the effect of ice and use submerged aeration systems. Attached growth systems such as trickling filters and rotating biological contactors must not be used unless they are adequately enclosed and protected from the cold. Suspended growth systems with short solids retention times such as conventional activated sludge must be avoided.

C-3.2.2.3.1 Modifications for Viscosity and Dissolved Oxygen Variations.

All operations where operation is viscosity dependent must be corrected for increased viscosity. This includes sedimentation tanks, filters and wastewater treatment ponds. All processes which involve oxygen transfer will be aided by the increase solubility of oxygen at low temperatures; but to overcome the deleterious effect of increased viscosity, more mixing must be required. An absorption process such as oxygen bubble-water transfer is enhanced by the lower temperature but the lower viscosity reduces the rate of contact so that, overall, neither oxygen transfer nor absorption change in rate.

C-3.2.2.4 Insulation of Appurtenances.

Trash racks, bar screens, grit chambers, unit process tanks, biological reactors, aerators, gates, walkways and instrumental sensing devices must be enclosed, covered, heated, insulated and/or redesigned to withstand icing and snow pack.

C-3.3 SMALL TREATMENT SYSTEMS

C-3.3.1 Typical Military Installations.

A package plant is not typically desirable for an Installation's wastewater treatment plant with flow greater than 0.5 million gallons per day (0.022 m^3/s).

C-3.3.2 Wastewater Treatment Ponds/Lagoons.

Algae present in pond effluent represents one of the most serious performance problems associated with facultative ponds. The facultative pond is the easiest to maintain and stable to flow and load variations, but it also requires a large land area to maintain area BOD_5 loadings in a suitable range. The facultative pond has low capital and operating costs. For this lagoon type, allowable organic loadings are generally much higher in summer than in winter. The total containment facultative pond is applicable in climates where evaporative losses exceed rainfall.

The main advantage of aerated ponds compared with facultative lagoons is that they require less land area.

High-rate aerobic lagoons are limited to warm, sunny climates. The chief advantage of the high-rate aerobic pond is that it produces a stable effluent with low land and energy requirements and short detention times. However, operation is somewhat more complex than for a facultative pond and, unless an algae removal step is provided, the effluent will contain high suspended solids. Short detention times also mean that very little coliform die-off will result. Because of their mustow depths, paving or lining the ponds is required to prevent weed growth.