

ANNEX 2

WORKSHEETS

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Annex 2: Worksheets

4D Wastewater Treatment and Discharge

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Sector	Waste		
Category	Domestic Wastewater Treatment and Discharge		
Category Code	4D1		
Sheet	1 of 8 Estimation of Total Organically Degradable Material in Domestic Wastewater (Updated)		
STEP 1			
Region or City	A	B	C
	Population (P) cap	Degradable organic component (BOD) (kg BOD/cap/yr) ¹	Organically degradable material in wastewater (TOW) (kg BOD/yr) C = A x B
			Total
¹ g BOD/cap/day x 0.001 x 365 = kg BOD/cap/yr			

Sector		Waste				
Category		Domestic Wastewater Treatment and Discharge				
Category Code		4D1				
Sheet		2 of 8 Estimation of Total Organics in Domestic Wastewater by Treatment Discharge Pathway or System (New)				
STEP 1						
Type of treatment or discharge pathway	Income group	A	B	C	D	E
		Organically degradable material in wastewater	Fraction of population income group <i>i</i> in inventory year	Degree of utilization of treatment/discharge pathway or system, <i>j</i> , for each income group <i>i</i>	Correction factor for industrial BOD discharged in sewers	Total organics in wastewater by income group and pathway
		(TOW) (kg BOD/yr)	(U _{<i>i</i>}) (fraction)	(T _{<i>ij</i>}) (fraction)	(I _{<i>j</i>}) ¹	(TOW _{<i>ij</i>}) (kg BOD/yr)
		Sheet 1 of 8				E = A x B x C x D
	Rural					
	Urban high income					
	Urban low income					
	Rural					
	Urban high income					
	Urban low income					
	Rural					
	Urban high income					
	Urban low income					
Add as needed						
					Total	

¹ Correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00) (see page 6.22 of the 2019 Refinement).

Sector	Waste			
Category	Domestic Wastewater Treatment and Discharge			
Category Code	4D1			
Sheet	3 of 8 Estimation of Organic Component Removed as Sludge from Aerobic Treatment Plants (New)			
STEP 1A				
Type of treatment or discharge	A	B	C	D
	Amount of sludge removed from wastewater treatment (S _{mass}) (tonnes sludge/yr)	Sludge factor ¹ (K _{rem}) (kg BOD/kg sludge)	Conversion factor of tonnes into kg 1000	Organic component removed as sludge (S _{aerobic}) (kg BOD/yr)
				D = A x B x C
Add as needed				
				Total
¹ See Table 6.6a for default values.				

Sector	Waste			
Category	Domestic Wastewater Treatment and Discharge			
Category Code	4D1			
Sheet	4 of 8 Estimation of Organic Component Removed as Sludge from Septic Systems (New)			
STEP 1A				
Type of treatment or discharge	A	B	C	D
	Total organics in septic systems	Fraction of population managing their septic tank in compliance ¹	Faction of organics removed in sludge ²	Organic component removed as sludge
	(TOW _{septic}) (kg BOD/yr)	(F) (fraction)	(0.5) (fraction)	(S _{septic}) (kg BOD/yr)
	Sheet 2 of 8			D = A x B x C
Add as needed				
				Total
¹ Default value is 0.5. ² Default value is 0.5.				

Sector	Waste			
Category	Domestic Wastewater Treatment and Discharge			
Category Code	4D1			
Sheet	5 of 8 Estimation of Total Organics in Treated Domestic Wastewater Effluent (New)			
STEP 1B				
Type of treatment or discharge	A	B	C	D
	Organically degradable material in wastewater	Fraction of wastewater treated exclusively by each wastewater treatment type j^1	Faction of organics removed in sludge ²	Total organics in treated domestic wastewater effluent
	(TOW) (kg BOD/yr)	(T_j) (fraction)	($TOW_{REM,j}$) (fraction)	($TOW_{EFFtreat}$) (kg BOD/yr)
	Sheet 1 of 8			$D = A \times B \times (1 - C)$
Add as needed				
			Total	
¹ See Table 6.5. ² See Table 6.6b.				

Sector	Waste		
Category	Domestic Wastewater Treatment and Discharge		
Category Code	4D1		
Sheet	6 of 8 Estimation of CH₄ Emission Factor for Domestic Wastewater		
STEP 2			
Type of treatment or discharge	A	B	C
	Maximum methane producing capacity	Methane correction factor for each treatment system	Emission factor
	(B ₀) (kg CH ₄ /kgBOD)	(MCF _j)	(EF _j) (kg CH ₄ /kg BOD)
			C = A x B
Add as needed			

Sector		Waste				
Category		Domestic Wastewater Treatment and Discharge				
Category Code		4D1				
Sheet		7 of 8 Estimation of CH ₄ Emissions from Domestic Wastewater for Each Income Group and Treatment Discharge Pathway (Updated)				
STEP 3						
Type of treatment or discharge pathway	Income group	A	B	C	D	E
		Total organics in wastewater by income group and pathway	Sludge removed	Emission Factor	Methane recovered and flared	Net methane emissions
		(TOW _i) (kg BOD/yr)	(S _i) ¹ (kg BOD/yr)	(EF _j) (kg CH ₄ /kg BOD)	(R _j) (kg CH ₄ /yr)	(CH ₄) (kg CH ₄ /yr)
		Sheet 2 of 8	Sheet 3 and 4 of 8	Sheet 6 of 8		E = [(A - B) x C - D]
	Rural					
	Urban high income					
	Urban low income					
	Rural					
	Urban high income					
	Urban low income					
	Rural					
	Urban high income					
	Urban low income					
Add as needed						
Total						
¹ Default value is zero for systems other than centralized aerobic treatment systems or septic systems.						

Sector	Waste	
Category	Domestic Wastewater Treatment and Discharge	
Category Code	4D1	
Sheet	8 of 8 Estimation of Total CH₄ Emissions from Domestic Wastewater Treatment and Discharge (New)	
STEP 3		
A	B	C
Total methane emissions (CH ₄) (kg CH ₄ /yr)	Conversion factor of kg into Gg 10 ⁻⁶	Total methane emissions (CH ₄) (Gg CH ₄ /yr)
Sheet 7 of 8		C = A x B

Sector	Waste			
Category	Industrial Wastewater Treatment and Discharge			
Category Code	4D2			
Sheet	1 of 3 Total Organic Degradable Material in Wastewater for each Industry Sector			
STEP 1				
	A	B	C	D
Industry Sectors	Total industry product (P _i) (t _{product} /yr)	Wastewater generated (W _i) (m ³ /t _{product})	Chemical Oxygen Demand (COD _i) (kg COD/m ³)	Total organic degradable material in wastewater for each industry sector (TOW _i) (kg COD/yr)
				D = A x B x C
Industrial sector 1				
Industrial sector 2				
Industrial sector 3				
add as needed				
			Total	

Sector	Waste		
Category	Industrial Wastewater Treatment and Discharge		
Category Code	4D2		
Sheet	2 of 3 Estimation of CH₄ Emission Factor for Industrial Wastewater		
STEP 2			
Type of treatment or discharge	A	B	C
	Maximum Methane Producing Capacity (B ₀) (kg CH ₄ /kg COD)	Methane Correction Factor for the Treatment System (MCF _i)	Emission Factor (EF _i) (kg CH ₄ /kg COD)
			C = A x B
add as needed			

Sector	Waste						
Category	Industrial Wastewater Treatment and Discharge						
Category Code	4D2						
Sheet	3 of 3 Estimation of CH ₄ Emissions from Industrial Wastewater						
STEP 3							
		A	B	C	D	E	F
Industrial sector	Type of treatment or discharge pathway	Total organic degradable material in wastewater for each industry sector (TOW _i) (kg COD/yr)	Sludge removed in each industry sector (S _i) (kg COD/yr)	Emission factor for each treatment system (EF _i) (kg CH ₄ /kg COD)	Recovered CH ₄ in each industry sector (R _i) (kg CH ₄ /yr)	Conversion factor of kg into Gg 10 ⁻⁶	Net methane emissions (CH ₄) (kg CH ₄ /yr)
		Sheet 1 of 3		Sheet 2 of 3			$F = [(A - B) \times C] - D \times E$
Industrial sector 1							
Industrial sector 2							
Industrial sector 3							
add as needed							
						Total	

Sector	Waste						
Category	Domestic Wastewater Treatment and Discharge						
Category Code	4D1						
Sheet	1 of 5 Estimation of Nitrogen in Domestic Wastewater (New)						
STEP 1							
Type of treatment or discharge pathway	A	B	C	D	E	F	G
	Population served by the treatment pathway, <i>j</i>	Per capita protein consumption	Fraction of nitrogen in protein	Additional nitrogen from household products ¹	Fraction of non-consumed protein and additional nitrogen from household products	Fraction of industrial and commercial co-discharged protein	Total nitrogen in domestic wastewater (treated) by treatment pathway
	($P_{\text{treatment}}$) (people/year)	(Protein) (kg/person/year)	(F_{NPR}) (kg N/kg protein)	N_{HH} (fraction)	($F_{\text{NON-CON}}$) (-)	($F_{\text{IND-COM}}$) (-)	($TN_{\text{DOM},j}$) (kg N/year)
							$G = (A \times B \times C \times D \times E \times F)$
Add as needed							
							Total

¹ Default value is 1.1.

Sector	Waste	
Category	Domestic Wastewater Treatment and Discharge	
Category Code	4D1	
Sheet	2 of 5 Estimation of Protein Consumed (New)	
STEP 1		
A	B	C
Annual per capita protein supply (Protein _{SUPPLY}) (kg protein/person/year)	Fraction of protein consumed (FPC) (fraction)	Protein consumed (Protein) (kg protein/person/year)
		C = (A x B)
	Total	

Sector	Waste			
Category	Domestic Wastewater Treatment and Discharge			
Category Code	4D1			
Sheet	3 of 5 Estimation of Nitrogen in Effluent from Domestic Wastewater (New)			
STEP 1				
Type of treatment or discharge pathway	A	B	C	D
	Total nitrogen in domestic wastewater (TN _{DOM}) (kg N/year)	Fraction of wastewater treated exclusively by each wastewater treatment type <i>j</i> (T _{<i>j</i>}) (fraction)	Fraction of total wastewater nitrogen removed during wastewater treatment per treatment type <i>j</i> (N _{REM,<i>j</i>}) (-)	Total nitrogen in effluent (N _{EFFLUENT,DOM}) (kg N/year)
	Sheet 1 of 4			$D = [A \times (B \times (1 - C))]$
Add as needed				
Total				

Sector		Waste					
Category		Domestic Wastewater Treatment and Discharge					
Category Code		4D1					
Sheet		4 of 5 Estimation of N ₂ O Emissions from Domestic Wastewater Treatment Plants for each Income Group and Treatment Discharge Pathway or System (New)					
STEP 3							
Income group	Type of treatment or discharge pathway	A	B	C	D	E	F
		Fraction of population in income group <i>i</i> in inventory year (U _{<i>i</i>}) (fraction)	Degree of utilisation of treatment/discharge pathway or system, <i>j</i> , for each income group, <i>i</i> (T _{<i>ij</i>}) (fraction)	Emission factor for treatment/discharge pathway or system, <i>j</i> (EF _{<i>j</i>}) (kg N ₂ O-N/kg N)	Total nitrogen in domestic wastewater (treated) (TN _{DOM}) (kg N/year)	Conversion factor of kg N ₂ O-N into kg N ₂ O 44/28	N ₂ O emissions from domestic wastewater treatment plants in inventory year (N ₂ O Plants _{DOM}) (kg N ₂ O/yr)
					Sheet 1 of 4		F = A x B x C x D x E
Rural							
Urban high income							
Urban low income							
						Total	

Sector	Waste			
Category	Domestic Wastewater Treatment and Discharge			
Category Code	4D1			
Sheet	5 of 5 Estimation of N₂O Emissions from Domestic Wastewater Effluent (New)			
STEP 4				
Type of treatment or discharge pathway	A	B	C	D
	Nitrogen in effluent (N _{EFFLUENT,DOM}) (kg N/year)	Emission factor (EF _{EFFLUENT}) (kg N ₂ O-N/kg N)	Conversion factor of kg N ₂ O-N into kg N ₂ O 44/28	Total N ₂ O emissions (kg N ₂ O/year)
	Sheet 3 of 5	See Table 6.8a (New)		D = A x B x C
Total				

Sector	Waste			
Category	Industrial Wastewater Treatment and Discharge			
Category Code	4D2			
Sheet	1 of 4 Estimation of Nitrogen in Industrial Wastewater (New)			
STEP 1				
	A	B	C	D
Industry Sectors	Total industry product	Wastewater generated	Total nitrogen	Total nitrogen in industrial wastewater (treated)
	(P _i)	(W _i)	(TN _i)	(TN _{INDi})
	(t _{product} /yr)	(m ³ /t _{product})	(kg N/m ³)	(kg N/year)
				D = (A x B x C)
Industrial sector 1				
Industrial sector 2				
Industrial sector 3				
Add as needed				
Total				

Sector	Waste			
Category	Industrial Wastewater Treatment and Discharge			
Category Code	4D2			
Sheet	2 of 4 Estimation of Nitrogen in Effluent from Industrial Wastewater (New)			
STEP 1				
Type of treatment or discharge pathway	A	B	C	D
	Total nitrogen in industrial wastewater (TN _{INDI}) (kg N/year)	Fraction of wastewater treated exclusively by each wastewater treatment type <i>j</i> (T _{<i>j</i>}) (fraction)	Fraction of total wastewater nitrogen removed during wastewater treatment per treatment type <i>j</i> (N _{REM,<i>j</i>}) (-)	Total nitrogen in effluent (N _{EFFLUENT,IND}) (kg N/year)
	Sheet 1 of 4			D = [A x (B x (1 - C))]
Add as needed				
Total				

Sector	Waste				
Category	Industrial Wastewater Treatment and Discharge				
Category Code	4D2				
Sheet	3 of 4 Estimation of N₂O Emissions from Industrial Wastewater Treatment Plants (New)				
STEP 3					
Type of treatment	A	B	C	D	E
	Degree of utilisation of treatment/discharge pathway or system, <i>j</i> , for each industry, <i>i</i> (T _{<i>i,j</i>}) (fraction)	Emission factor for treatment/discharge pathway or system, <i>j</i> (EF _{<i>j</i>}) (kg N ₂ O-N/kg N)	Nitrogen in wastewater from industry, <i>i</i> (treated) (TN _{IND<i>i</i>}) (kg N/year)	Conversion factor of kg N ₂ O-N into kg N ₂ O 44/28	N ₂ O emissions from industrial wastewater treatment plants in inventory year (N ₂ O Plants _{IND}) (kg N ₂ O/year)
			Sheet 1 of 4		E = (A x B x C x D)
Industrial sector 1					
Industrial sector 2					
Industrial sector 3					
Add as needed					
Total					

Sector	Waste			
Category	Industrial Wastewater Treatment and Discharge			
Category Code	4D2			
Sheet	4 of 4 Estimation of N₂O Emissions from Industrial Wastewater Effluent (New)			
STEP 4				
Type of treatment or discharge pathway	A	B	C	D
	Nitrogen in effluent (N _{EFFLUENT,IND}) (kg N/year)	Emission factor (EF _{EFFLUENT}) (kg N ₂ O-N/kg N)	Conversion factor of kg N ₂ O-N into kg N ₂ O 44/28	Total N ₂ O emissions from industrial wastewater effluent (N ₂ O _{Effluent,IND}) (kg N ₂ O/year)
	Sheet 2 of 4	See Table 6.8a		D = A x B x C
Add as needed				
Total				