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Time duration: 2 hrs
MM: 60

Q1 A municipal council decides to close a park and utilize the space for constructing an office complex. The park is spread over 2.5 sq. km and houses more than 600 trees of 50 different species. Besides, park has large variety of flowers and ornamental plants. Park also houses a one biodiversity museum and laboratory for taxonomy and entomology students. Every day people visit the park from various locations for recreational and fitness activities. The park also provides habitat to large number of fauna population. Recently a photographer of the city got an international award for clicking photographs of rare and migratory birds. To protect the park, you need to carry out valuation of the park using contingent valuation method. Prepare the following — 15

a. A scenario to be presented to the users/respondents for sensitization
b. Identify various groups of people to be surveyed for valuation
c. 12 questions for Survey. Also indicate the type of value for which the question is framed.

Q2 a Discuss the purpose and development of EIA — 6

Q2 b In an EIA study, primary, secondary and subsequent impacts (initial condition, consequent condition and their effects) of five major actions of project are identified and given below. Actions and Impacts of along with their magnitude and importance with probability of occurrence are also shown below. Draw Network diagram showing the direct and indirect impact of project actions and rank the actions as per the impact score. Also draw tree diagram showing the root cause analysis of Environmental Impact. — 10

Possible Adverse Impacts		
Initial Condition	**Result Condition**	**Effect**
Increased runoff (F)	Flooding (J)	Erosion (N)
Pollution of Ground Water (G)	Drinking Water Quality (K)	Health Hazard (O)
Removal of Top Soil (H)	Decreased Fertility (L)	Loss of Biodiversity (P)
Gas Emission (I)	Air Quality (M)	Loss of Infrastructure (Q)

Relation Between Actions and Impacts of four Branches				
Action	Impacts			
A	→ (F)	→ (J)	→ (N)	
B	→ (G)	→ (K)	→ (O)	
C	→ (H)	→ (L)	→ (P)	
D				
E	→ (I)	→ (M)	→ (Q)	

Relation among different type of Impacts, their magnitude and Importance with Probability of Occurrence						
Impact	**Impact Score (1-10 Scale)**					
	Magnitude	**Importance**	**Probability of Occurrence**			
F	6	3	A →	F (0.6)		
G	4	4	B →	G (0.9)		
H	4	5	C →	H (0.6)	E →	H (0.5)
I	3	5	E →	I (0.6)		
J	3	9	F →	J (0.4)		
K	5	8	G →	K (0.4)		
L	8	6	H →	L (0.9)		
M	6	10	I →	M (0.6)	H →	M (0.4)
N	4	5	J →	N (0.5)		
O	3	7	K →	O (0.9)		
P	5	8	L →	P (0.4)		
Q	3	5	M →	Q (0.6)		

Q3 Compare three aerobic wastewater treatment plants on the basis of Global Warming Potential (GWP) and Eutrophication Potential (EP). The wastewater treatment plants need to treat 2000 m^3/d wastewater having an inlet BOD_5 of 300 mg/L, 100 mg/L total nitrogen, and 40 mg/L Phosphorus. The data pertaining to the performances of plant is given below 15

	BOD removal efficiency (%)	Reduction of Total Nitrogen (%)	Bioavailable Nitrogen treated wastewater	Reduction of Total Phosphorus (%)	Bioavailable Phosphorus in treated wastewater
Plant 1	90	30	78	20	78
Plant 2	80	45	70	30	70
Plant 3	85	32	73	35	73

GWP (CO_2 Eq.) of CO_2 is 1 and of CH_4 is 21. Only Bioavailable Nitrogen is responsible for Eutrophication. EP (PO_4^{+3} eq) of NH_4^+ *and* NO_3^{-1} in water is 0.33 and 0.1 respectively. EP of PO_4^{+3} is 3.06.

Brief description of different process is given below for better understanding of the processes.

Aerobic Wastewater Treatment System: *Aerobic biological wastewater treatment Processes consist of two unit operation aeration followed by clarification. In a perfect aerobic system carbonous organic matter of wastewater is converted into new biomass or to* CO_2. *Total Nitrogen is converted through Ammonification and nitrification into* NH_4^+, NO_3^{-1}, NO_2^{-1} N_2, *and non-bioavailable nitrogenous compounds. Non-biovailable and* NH_4^+, NO_3^{-1}, NO_2^{-1} *compounds remain in treated wastewater and bioavailable compounds leads to Eutrophication. Total bioavailable Phosphorous is in form of P and* PO_4^{+2}.

Estimation of CO_2 Emission from wastewater treatment plants:

Following equation provide a general means of estimating the CO_2 emission directly from any type of wastewater treatment process assuming all organic carbon removed from the wastewater is converted to either CO_2, or new biomass.

$$CO_2 = 10^{-6} \times Q_{ww} \times OD \times Eff_{OD} \times CF_{CO2} (1-\lambda)$$

where:

CO_2 = CO_2 emission rate (Mg CO_2/hr)

Mg = Mega gram

Q_{ww} = Wastewater influent flow rate (m^3/hr)

OD = Oxygen demand of influent wastewater to the biological treatment unit determined as BOD_5 (mg/L)

Eff_{OD} = Oxygen demand (BOD) removal efficiency of the biological treatment unit

CF_{CO2} = Conversion factor for maximum CO_2 generation per unit of oxygen demand = 1.375 g CO_2/ g oxygen demand (BOD)

λ = Biomass yield (g C converted to biomass/g C consumed in the wastewater treatment process = 0.65).

Estimation of various forms of Bioavailable nitrogen in treated wastewater:

$$6H_2O + 5\ N = 3\ NH_4^+ + 2\ NO_3$$

Estimation of various forms of Bioavailable Phosphorus in treated wastewater:

All the bio available Phosphorus is present in PO_4^{+2} form

Q4 Write Short notes on (i) Malthusian margin, (ii) Ricardian rent, (iii) neo-Malthusian, (iv) weak and strong sustainability conditions, (v) social discount rate, (vi) environmental defense expenditures, (vii) sustainable national income (SNI). 14