SEEA – Water

Answers to questions on the emissions tables

Republic of Blue and its cities: Soda City, Northville and Green Port

Introduction

The exercise and associated questions builds on the physical supply and use tables exercise and questions and is designed to strengthen your understanding of the emissions tables of SEEA-Water. It does this using an imaginary country, called the "Republic of Blue", first introduced in the previous exercise. While the Republic of Blue is an imaginary country, the data presented are consistent with real data from countries.

Before you start

Before you attempt these exercises and questions you should first have completed the exercises and questions regarding physical supply and use tables and reviewed Chapter 4 of the SEEA-Water.

Soda City: An example of the emissions to water

Water discharges and emissions in Soda City

Figure 1 shows the flows of water and the emissions of nitrogen in Soda City. These flows include the discharges of wastewater to sewerage (ISIC 37) of 22,000,000 m^3 and a return of 364,000,000 m^3 of water to the environment by economic activities, with 321,000,000 m^3 from the electricity industry (ISIC 35), 20,000,000 m^3 from the sewerage industry (ISIC 37), 18,000,000 m^3 from the water supply industry (including 17,000,000 m^3 in losses) and 5,000,000 m^3 from the manufacturing industries (ISIC 10-33). The flows of wastewater to sewerage (22,000,000 m^3) and the return flows to the environment (364,000,000 m^3) contain emissions of pollutants, including nitrogen.

In the wastewater to sewerage 845 tonnes of nitrogen are emitted: 480 tonnes by households, 285 by other industries (ISIC 38, 39, 45-99) and 80 tonnes by the manufacturing industries (ISIC 10-33). The sewerage industry (ISIC 37), after treating the wastewater, returns 20,000,000 m^3 of water to the environment, containing 549 tonnes of nitrogen. In addition to the 549 tonnes of nitrogen emitted to environment by the sewerage industry (ISIC 37) a further 24 tonnes of nitrogen are emitted directly to the environment by the manufacturing industries (ISIC 10-33), making the total emissions of nitrogen to environment of 573 tonnes. Note that while water is returned to the environment by the electricity (ISIC 35) and water supply (ISIC 36) industries, that this water does not contain nitrogen.

These flows of nitrogen in Soda City are presented in the standard SEEA-Water emissions tables. The first shows the gross and net emissions and the second the emissions by the sewerage industry (ISIC 37).

Gross and net emissions and the reallocation of emissions by the sewerage industry

The emissions by the sewerage industry are redistributed to the industries and households that supplied the nitrogen, enabling the net emissions to be calculated. Gross emissions are all of the emissions from industries and households to the environment and to the sewerage industry (ISIC 37). The net emissions of industries and households are the sum

of the direct emissions to the environment (Line 1.a of Table 1), plus the share of emissions released to the environment by the sewerage industry (ISIC 37), which are shown in Line 2 of Table 1.

The net emissions are calculated by the application of a global abatement factor to the emissions of industry and households to the sewerage industry (Line 1.b). In this case the global abatement factor is 0.649 or 64.9%, which is the emissions of sewerage industry (549 tonnes) to the environment, divided by the emissions received from by the sewerage industry from industry and households (845 tonnes).

$$\text{Global abatement factor} = \frac{\text{Total emission by ISIC 37, line 4 of table 2}}{\text{Total of emissions to sewerage, line 1.b of table}}$$

$$= \frac{549}{845}$$

$$= 0.649$$

The global abatement factor is then applied to emissions to the sewerage industry for each of the industries and households to reallocate these emissions (Line 2 of Table 1) and then to calculate net emissions.

In this example, the manufacturing industries (ISIC 10-33) of Soda City discharge 80 tonnes of nitrogen to the sewerage industry (ISIC 37) and 24 tonnes directly to the environment. Gross emissions for this industry are 104 tonnes (= 80 + 24). Applying the global abatement factor of 0.649 to the 80 tonnes, gives 52 tonnes (= 0.649 x 80) and so net emissions are 76 tonnes, consisting of the 24 tonnes emitted directly to the environment (Line 1.a of Table 1) and 52 reallocated from the sewerage industry (line 2 table 1).

The households of Soda City discharge 480 tonnes of nitrogen to the sewerage industry (ISIC 37) but have no discharges directly to the environment. In this case gross emissions for this industry are 480 tonnes and applying the global abatement factor of gives 312 tonnes (= 0.649 x 480). As households do not have direct emissions to the environment and the net emissions are only 312 tonnes reallocated from the sewerage industry (Line 2 Table 1).

Figure 1: Soda City and surrounds

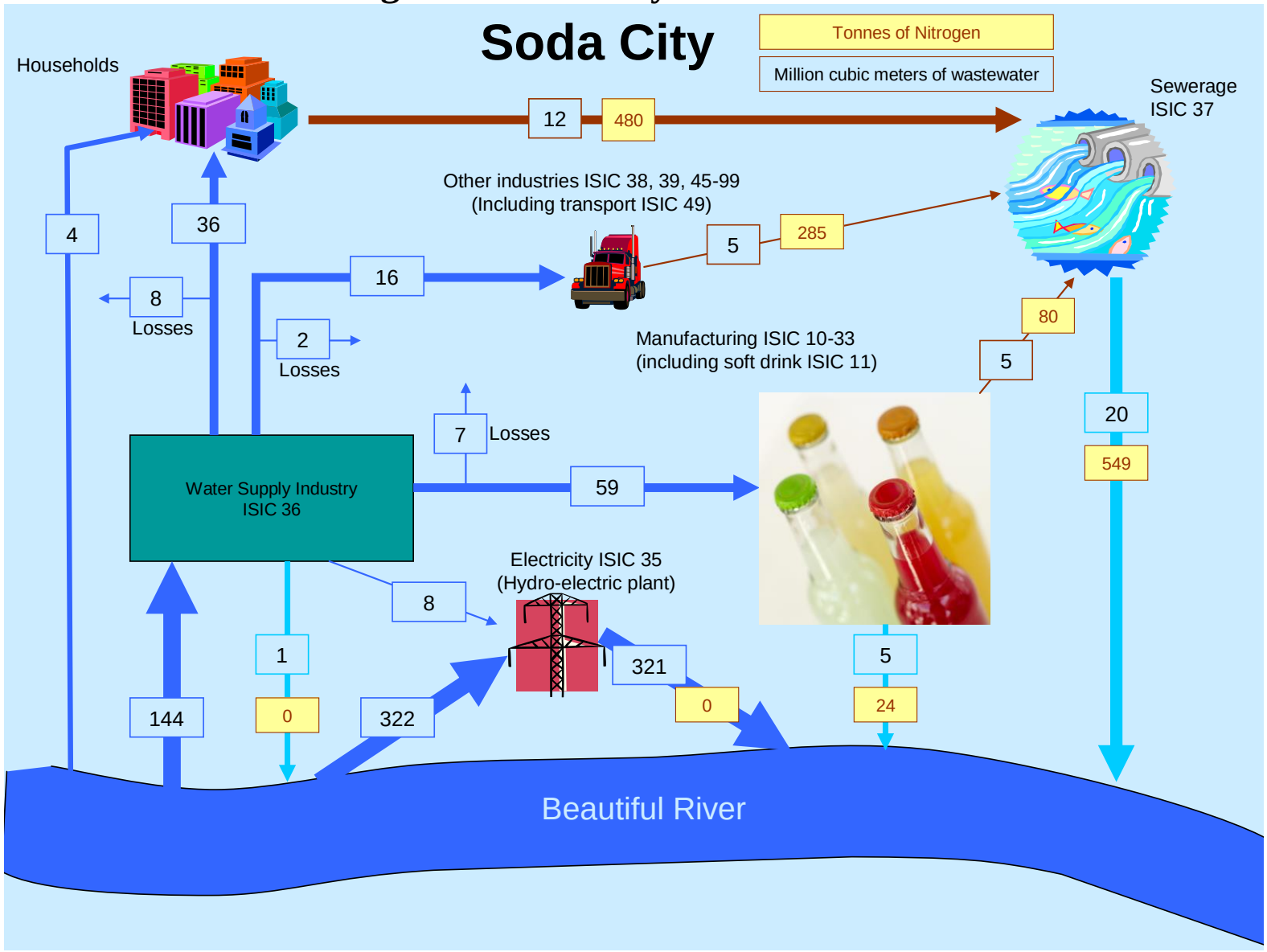

Table 1: Soda City – Gross and net emissions

Tonnes of Nitrogen

Pollutant	Industries (by ISIC categories)							Households	Rest of the world	Total
	1-3	5-33, 41-43	35	36	37	38,39, 45-99	*Industry total*			
1. Gross emissions (=1.a+1.b)	0	104	0	0		285	389	480		869
1.a. Direct emissions to water (=1.a.1+1.a.2=1.a.i+1.a.ii)	0	24	0	0		0	24	0		24
1.a.1 Without treatment	0	0	0	0		0	0	0		0
1.a.2 After on-site treatment	0	24	0	0		0	24	0		24
1.a.i To water resources	0	24	0	0		0	24	0		24
Surface water	0	24	0	0		0	24	0		24
Groundwater							0			0
1.a.ii To the sea							0			0
1.b. To Sewerage (ISIC 37)	0	80	0	0		285	365	480		845
2. Reallocation of emission by ISIC 37	0	52	0	0		185	237	312		549
3. Net emissions (=1a+2)	0	76	0	0		185	261	312		573

Table 2: Soda City –emissions by sewerage industry (ISIC 37)

Tonnes of Nitrogen

Pollutant	ISIC 37
4. Emissions to water (=4.a+4.b)	**549**
4.a. After treatment	549
To inland water resources	*549*
To the sea	
4.b.. Without treatment	
To inland water resources	
To the sea	

Questions on Soda City

1. How much wastewater is supplied by the households to the sewerage treatment plant?
   12,000,000 m^3 of water

2. How much nitrogen is in the wastewater supplied from households to the sewerage industry?
   480 tonnes of nitrogen

3. The hydroelectric power generator returns large volumes of water directly to the environment. How much nitrogen is emitted in these returns?
   0 tonnes

4. 4. How much water do the "other" industries (ISIC 38, 39, 45-99) return directly to the environment?
   0 m^3 of water

5. What is the amount of nitrogen is emitted by other industries (ISIC 38, 39, 45-99) to the sewerage industry?
   285 tonnes of nitrogen

6. What is the gross amount of nitrogen emitted by the manufacturing industries (ISIC 10-33)?
   104 tonnes of nitrogen

7. What is the net amount of nitrogen emitted by the manufacturing industries (ISIC 10-33)?
   76 tonnes of nitrogen

8. Why are the net and gross amounts of nitrogen emitted by households different?
   Because some of the nitrogen is removed from the water by the sewerage industry (ISIC 37) before being returned to the environment.

9. Are the emissions from ISIC 37 to the environment be reallocated back to the households and industries according to the proportion of:
   A. Wastewater supplied to sewerage and water returns to the environment by ISIC 37
   B. Nitrogen supplied to sewerage and emissions of nitrogen to the environment by ISIC 37 ✓

Northville: Completing the emissions tables

Introduction

Northville is an imaginary city and is located upstream from Soda City. Northville is surrounded by farms and a coal mine. The physical flows of water and associated emissions of nitrogen are represented in Figured 2, and the nitrogen emissions are also presented in Table 2. Note that the flows of water are shown in millions of meters cubed (=1,000,000 m^3) and emissions of nitrogen are presented as tonnes of nitrogen. Note that the emissions tables are currently incomplete.

Northville has the following characteristics:

- A population of 215,000
- An economy consisting of
  - Agriculture (ISIC 01)
  - Coal mining (ISIC 05), one of the mining industries (ISIC 05-09)
  - Electricity (ISIC 35)
  - Water supply (ISIC 36)
  - Sewerage (ISIC 37)
  - Other industries (ISIC 38,39, 45-99)
  - Households
- Wastewater and waterborne emissions are discharged to the:
  - Sewerage system
  - The Beautiful River (which also happens to be an important source of water too)

Water supply and use in Northville

In Northville the mining industry, the agricultural industry (which mainly consists of livestock farming and some horticulture), the electricity industry, and households all directly discharge water to the environment (i.e. return water to the environment). Any emissions contained in these returns are direct emissions to the environment. Households also discharge wastewater to the sewerage industry (ISIC 37), and other industries (ISIC 38, 39, 35-99) discharge their emissions to the sewerage industry.

Because of the agricultural activities (ISIC 01) in Northville there are significant non-point source emissions of nitrogen to water, which in principle should be included in the emissions tables but at this stage have not been included. These diffuse (i.e. non-point source emissions) end up in the beautiful river and the aquifer from which groundwater is abstracted.

The thermal electricity power plant (using coal from the nearby mine) abstracts 2,000,000 m^3 of water per year and returns 2,000,000 m^3 of water to the Beautiful River. In the case of the electricity power plant the returned water has no additional nitrogen added to the water, and as such there are no nitrogen emissions. There is, however some level of heat pollution (i.e. the water is warmer than what it was when abstracted.

The returns from the coal mine are treated but still contain a level of pollution, especially by sulfur which affects the acidity of the water. However the emissions being measured in the tables and diagram below are of nitrogen so this acidification and pollution by sulfur does not appear in these tables. There are many other pollutants that could also be measured but the local authorities have a limited budget for measuring pollution.

Figure 2: Northville

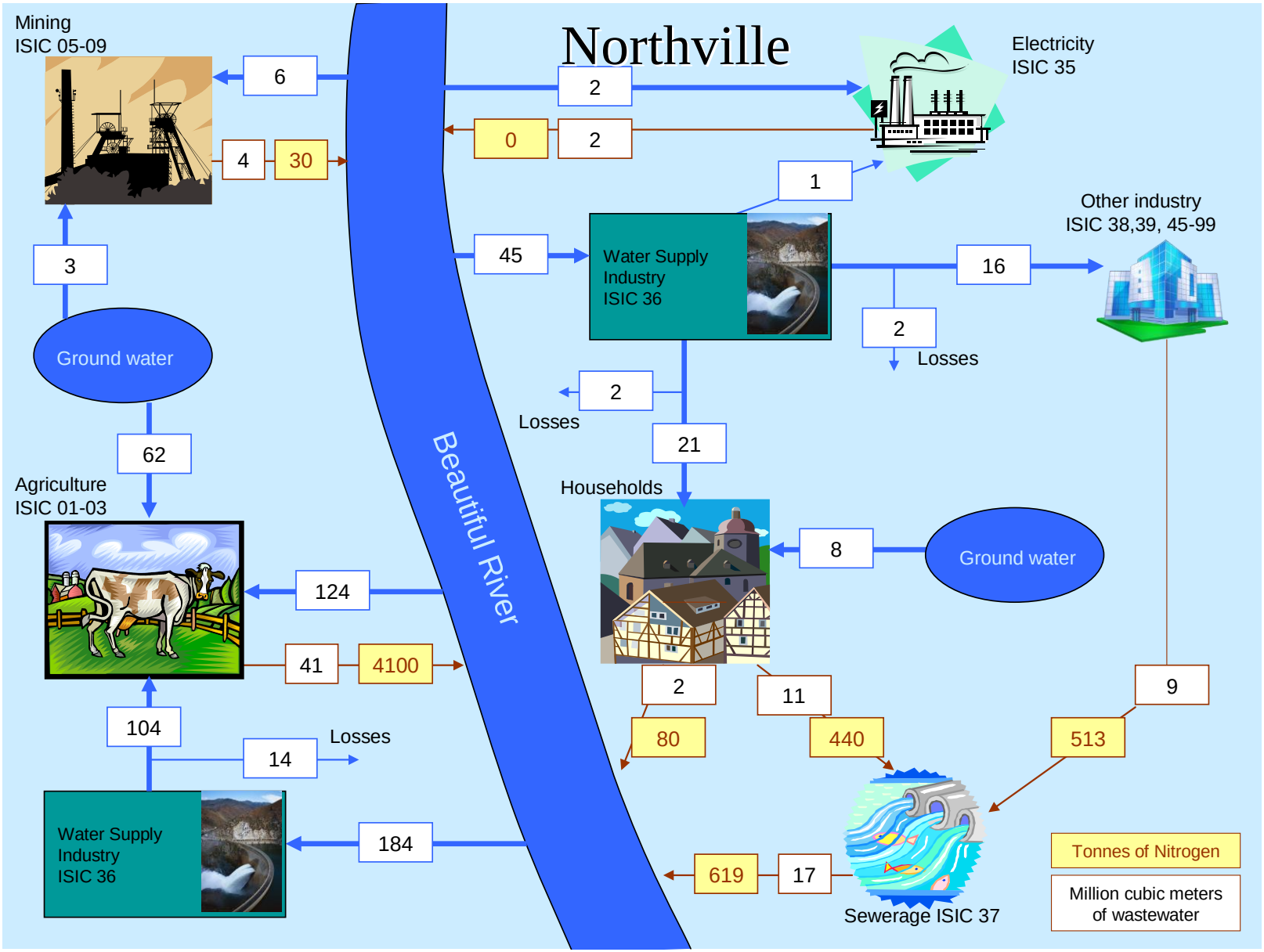

Table 3: Northville – emissions tables

Tonnes of Nitrogen

Pollutant	Industries (by ISIC categories)							Households	Rest of the world	Total
	1-3	5-33, 41-43	35	36	37	38,39, 45-99	*Industry total*			
1. Gross emissions (=1.a+1.b)	4,100	30	0	0		513	4,643	520		5,163
1.a. Direct emissions to water (=1.a.1+1.a.2=1.a.i+1.a.ii)	4,100	30	0	0		0	4,130	80		4,210
1.a.1 Without treatment	4,100	30	0	0		0	4,130	80		4,210
1.a.2 After on-site treatment	0	0	0	0		0	0	0		0
1.a.i To water resources	4,100	30	0	0		0	4,130	80		4,210
Surface water	4,100	30	0	0		0	4,130	80		4,210
Groundwater										0
1.a.ii To the sea										0
1.b. To Sewerage (ISIC 37)	0	0	0	0		513	513	440		953
2. Reallocation of emission by ISIC 37	0	0	0	0		333	333	286		619
3. Net emissions (=1a+2)	4,100	30	0	0		333	4,463	366		4,829

Table 4: Northville – emissions by ISIC 37

Tonnes of N

Pollutant	ISIC 37
4. Emissions to water (=4.a+4.b)	**619**
4.a. After treatment	619
To inland water resources	*619*
To the sea	
4.b.. Without treatment	
To inland water resources	
To the sea	

Exercise and questions on Northville

Use the diagrams showing the emissions to water around Northville to fill in the gaps in the emissions tables. The gaps in the tables are indicated by boxes filled with dots, like this: 

Once Tables 3 and 4 have been completed, use these tables, Fig. 2 and the information about Northville provided above to answer the following questions.

1. How much nitrogen is contained in wastewater sent by households for wastewater treatment by ISIC 37?

   440 tonnes of nitrogen

2. How much nitrogen is contained in water returned to the environment by households?

   80 tonnes of nitrogen

3. In Northville, who supplies wastewater to the sewerage industry (ISIC 37)

   Other industries (ISIC 38, 39, 45-99) and households

4. In Northville which industries indirectly emit waterborne nitrogen to environment?

   Other industries (ISIC 38, 39, 45-99) and households

5. In Northville, which industries directly emit waterborne nitrogen to the environment?

   Coal mining (ISIC 05), Agriculture (ISIC 01-03), and households

6. Which industry is the largest emitter of nitrogen to the environment, taking into account direct and indirect emissions?

   Agriculture (ISIC 01-03)

7. Are all of the emissions produced by the largest emitter actually recorded in the emissions tables?

   No, diffuse (non-point source) emissions are not recorded in the tables. This should be noted and always mentioned when presenting the table and the emissions data regarding agriculture from the table.

Green Port: Populating the emissions tables and calculating indirect emissions

Introduction

Green Port is an imaginary city, downstream from Northville and Soda City. It is the capital of the Republic of Blue and the flows of water, and the waterborne emissions contained in these flows, are shown in Figure 3. Note that the flows of water are shown in millions of meters cubed (=1,000,000 m^3) and waterborne emission of nitrogen are shown in tonnes.

Green Port has the following characteristics:

- A population of 1,256,000
- A diverse economy consisting of
  - Agriculture (ISIC 01), mostly fruit and vegetable growing, including grapes for wine
  - Manufacture (ISIC 10-32)
  - Water supply (ISIC 36)
  - Sewerage (ISIC 37)
  - Other industries (ISIC 38, 39, 45-99), including water transport (ISIC 50), accommodation and food service (55-56), computer programming (ISIC 62) and public administration (ISIC 84)
  - Households
- Most water is returned to the sea
- Some water is returned to the Beautiful River

Water supply and use in Green Port

Green Port has a diverse economy producing large volumes of wastewater. Most of this wastewater goes to a wastewater treatment plant where 20,000,000 m^3 of water is reused after treatment (with nearly 100% removal of nitrogen), and 87,000,000 m^3 receives tertiary wastewater treatment (with 84% removal of nitrogen) before 72,000,000 m^3 of water is disposed of at sea (note: water is lost in evaporation during treatment).

9,000,000 m^3 of water are returned to the beautiful river, of which 2,000,000 m^3 are returned by the electricity plant without any added nitrogen load (i.e. without any emissions). 7,000,000 m^3 of water are discharged after on-site treatment by manufactures to the Beautiful River containing 242 tonnes of nitrogen.

Like Northville, agriculture is a significant user of water in Green Port; however the agriculture industry around Green Port is dominated by horticultural activities, fruit growing and the growing of grapes for wine. Diffuse emissions from the agriculture industry surrounding Green Port are not measured in the diagram nor recorded in the emissions tables, although they should be. Only emissions to the sewerage industry are measured (2430 Tonnes).

Figure 3: Green Port

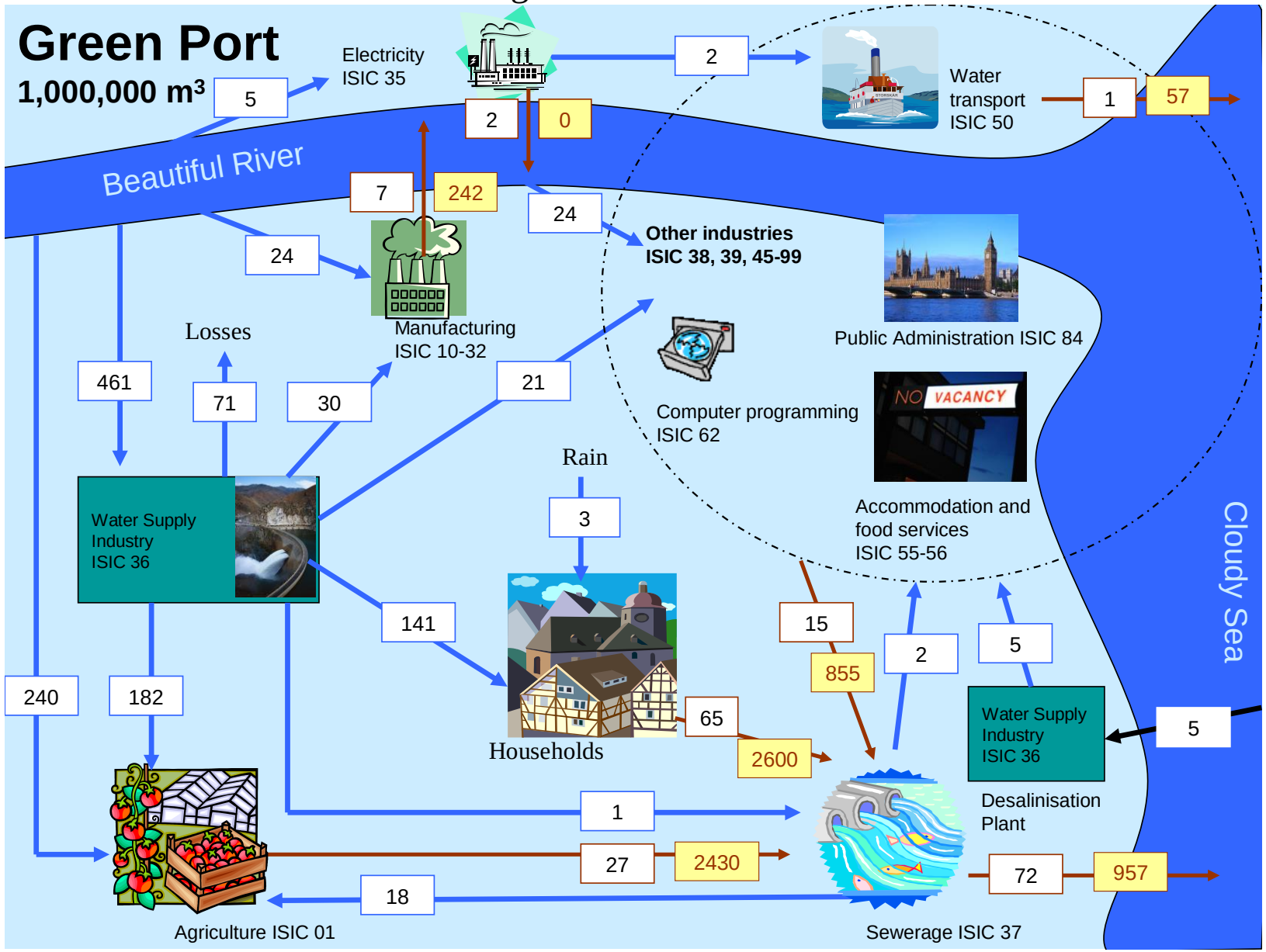

Table 5: Green Port – physical supply and use table

Tonnes of Nitrogen

Pollutant	Industries (by ISIC categories)							Households	Rest of the world	Total
	1-3	5-33, 41-43	35	36	37	38,39, 45-99	*Industry total*			
1. Gross emissions (=1.a+1.b)	2,430	242	0	0		912	3,584	2,600		6,184
1.a. Direct emissions to water (=1.a.1+1.a.2=1.a.i+1.a.ii)	0	242	0	0		57	299	0		299
1.a.1 Without treatment										
1.a.2 After on-site treatment										
1.a.i To water resources	0	242	0	0		57	299	0		299
Surface water	0	242	0	0			242			242
Groundwater										0
1.a.ii To the sea						57	57			57
1.b. To Sewerage (ISIC 37)	2,430	0	0	0		855	3,285	2,600		5,885
2. Reallocation of emission by ISIC 37	395	0	0	0		139	534	423		957
3. Net emissions (=1a+2)	395	242	0	0		196	833	423		1,256

Table 6: Green Port – Emissions from ISIC 37

Tonnes of N

Pollutant	ISIC 37
4. Emissions to water (=4.a+4.b)	**957**
4.a. After treatment	957
To inland water resources	
To the sea	*957*
4.b.. Without treatment	
To inland water resources	
To the sea	

Exercise and questions on Green Port

Use the diagram (Figure 3) showing the physical supply and use of water and the waterborne emissions of nitrogen contained in these flows, to fill the emissions tables (Tables 5 & 6).

Be careful of the other industries (ISIC 38, 39, 44-99) which includes the industries water transport (ISIC 50), accommodation and food service (ISIC 55 and 56) computer programming (ISIC 62) and public administration (ISIC 84). These are all grouped together and this is indicated by them all being within the dotted circle in Figure 3.

After completing Tables 5 and 6, use these tables along with Figure 3 and the information above to answer the following questions.

1. Which industry has the least emissions of nitrogen to water?

   Electricity ISIC 35 (0 tonnes of nitrogen). You could also say the Water Supply Industry ISIC 36 (0 tonnes of nitrogen) although the water supply industry does not return water to the environment in the diagram for Greenport.

2. Which industry from Green Port pollutes the Beautiful River the most?

   Manufacturing (ISIC 10-32) which emits 242 tonnes of nitrogen into the Beautiful River.

3. Where do indirect emissions go to?

   The sea (this is where the sewerage industry ISIC 37 return the water after treatment).

4. Which industry is responsible for largest quantity of indirect emissions to the environment?

   Agriculture (ISIC 01-03) is the "industry" responsible for the largest quantity of indirect emissions, sending 2430 tonnes of nitrogen to the sewerage industry (ISIC 37). Households, however, send 2600 tonnes of nitrogen to the sewerage industry and are therefore responsible for the largest quantity of indirect emissions to the sea.

5. What percentage of ISIC 37's emissions should be reallocated to:
   - Agriculture? 41%
   - Households? 44%
   - Other industries (ISIC 38, 39, 44-99)? 15%

6. You have been asked to include diffuse emissions of waterborne nitrogen in the emissions accounts.
   - What information would you need to do this?

These emissions will have to be estimated using coefficients or by some model (that uses coefficients). The information needed to estimate these emissions depends on what coefficients are available, for example are there coefficients for quantity of nitrogen from fertilizer that is "normally" dissolved into surface runoff or lost to groundwater? If there are then this coefficient could be applied to estimates of the amount of fertilizer applied. However such estimates of diffuse emissions make large assumptions and can lead to misleading results, for example if there is unusually high rainfall when fertilizer is applied by farmers then more nitrogen will runoff than normal.

- Where would you record these emissions in the Table 5?

  Non-point source (diffuse) emissions should be recorded in Table 5 as direct emissions to the environment without treatment. Special knowledge will be required to allocate these emissions to either surface water or groundwater. Some models may allow this, but any such estimates are likely to have large uncertainties.