Water Classrooms 3-3 (version 2)

Wastewater

Teaching plan for learning on water for middle school students

Under a project initiated by the Living Waters Museum, Centre for Water Research, IISER Pune and Research and supported by Transforming Education for Sustainable Futures, IIHS, Bangalore

3-3-1 Proposed plan

Lesson Plan number	WC-3-3
Topic	Wastewater
Discipline	Civics, environmental sciences
Time	60 to 75 minutes (can be divided into multiple sessions)
Prior learning	Module-1 – Topics WC-1-1 (Water and 'my'self) and WC-1-2 (Where does my water come from) and WC-1-5 (Water and disease)
Learning objectives	Students will be able to: ● *Describe* wastewater and different types of wastewater ● *Explain* the need to reuse wastewater and *list* some methods of reusing wastewater at home ● *List* some practices that avoid or reduce nutrient loads in domestic wastewater ● *Explain* potential impacts of improper disposal and the need for appropriate treatment of wastewater ● After a visit to Pashan Lake, *explain* how sewage inflows lead to disturbance of the ecosystem balance, especially growth of hyacinth

<table>
<tr><td>Learning outcomes</td><td>1. Students can identify components of wastewater
2. Students can describe where and how wastewater flows in structures around them.
3. Students can identify ways in which wastewater can affect natural water bodies
4. Students can devise ways in which negative affects of wastewater on natural water bodies can be reduced.</td></tr>
<tr><td>Resources/materials</td><td>Google map of western Pune showing Pashan Lake and upstream regions.
Whiteboard/blackboard. Worksheets. Powerpoint slides and projector.</td></tr>
<tr><td>Use of teaching time</td><td>5 mins
Introduce students to the topic wastewater. Facilitator/educator may help students recall what they learnt in Topics 1-1, 1-2, 1-5.

3-3-1a What is wastewater (indoors or outdoors)
5-10 mins
Facilitator/educator will ask students to recall the uses of water, and what happens to the water we use? Is anything added to the used water for each of the ways we use our water? Allow students to brainstorm and generate a list of materials that get added for each use of water.
Facilitator/educator will share copies of WC-3-3-Activity-I (table below). Students may match the activity to the substances added.
<table><tr><th>Activity</th><th>Materials in the used water</th></tr><tr><td>1. Bath and toilet</td><td>A. Detergents</td></tr><tr><td>2. Run-off from fields</td><td>B. Food scraps and dish washing soap</td></tr><tr><td>3. Washing kitchen utensils</td><td>C. Fertilizers and pesticides</td></tr><tr><td>4. Washing clothes</td><td>D. Body wastes and soap</td></tr></table></td></tr>
</table>

	Answers - 1D, 2C, 3B, 4A Students may have seen open drains or pipes to convey used water away from the point of use. Facilitator/educator will explain that used water or wastewater may go through drains or pipes and eventually join a larger nalla, pond or lake, or river. *Refer to – Background content for facilitator/educator – section 3-3-2a.* **After 3-3-1a, facilitator/educator may choose to continue to either 3-3-1b OR 3-3-1c depending on their location or other considerations** **3-3-1b - Impact of untreated sewage on aquatic ecosystems** **30 mins** (indoors or outdoors, at Pashan Lake in Pune) Facilitator/educator would require the following materials ● Worksheet for WC-3-3-Activity-I ● A2 or A1 size print of a map of western Pune showing the origin of Ramnadi and upto its confluence with the Mula river. 1. While at Pashan lake, facilitator/educator will explain the history of the lake and that Ramnadi and smaller streams bring water to the lake. In a classroom, they may also use the following visual story about Pashan lake and Ramnadi: https://punyachepaani.livingwatersmuseum.org/story/ramnadi-pashan-lake/

	Facilitator/educator will explain the concept of upstream* and downstream in a river. *If we select a reference point in a river, then downstream is any point in the direction of the flow of water. Upstream is any point against the flow of water as per the reference point. Facilitator/educator will ask which are the upstream* regions and if any students have visited these regions. On a map, the facilitator/educator will point out Bhugaon and Bhukum and other upstream areas and show the land-use including fields and residential areas in these regions and some of the streams leading to Ramnadi. 2. Facilitator/educator will ask what happens to the water from these fields, villages and town that has been used. 3. Facilitator/educator will ask students if water that has been used is dirty and if we can use it again? *Students may respond that used water is dirty, and we cannot use it again or that we can use it again after treatment.* 4. Facilitator/educator will explain that sewage contains: a. Food waste, human waste, cleaning materials etc b. Bacteria, viruses (such as from human waste and rotten food scraps), poisonous or corrosive chemicals (such as from cleaning materials) which can cause diseases if the sewage is not treated.

c. Nitrates and phosphates which come from human waste and food waste (facilitator/educator will explain that food or vegetables, grains and meats we eat are mainly made up of carbon, nitrogen, and phosphorus). These nitrates and phosphates promote the growth of plants; while in general we talk about growing more plants, the large quantity of these nutrients in sewage water causes high growth of aquatic plants when sewage enters a waterbody, disturbing the balance of the ecosystem.

5. Facilitator/educator will explain that uncontrolled growth of algae or other aquatic plants in a pond or lake may disturb the natural balance of the water ecosystem. Sewage encourages the rapid growth of algae, which then use up excessive amounts of oxygen in the water for their respiration, leading to the death of other organisms in the water, who don't get enough oxygen.

6. While at Pashan lake, facilitator/educator will show students the water hyacinth (*Pontederia crassipes*) accumulated at the surface or side of the lake.
   a. They will ask students if they know the plant. If any dry hyacinth plants are available show the bulbous, spongy stalks that help the plant stay afloat.
   b. They will ask students why water hyacinth grows so much in Pashan Lake. Facilitator/educator will inform students that as water hyacinth floats on the surface of

	the water with the spongy stalks, the plants form a thick mat which reduces the light and oxygen availability for the life forms in the lake, below the surface. *Refer to – Background content for facilitator/educator – section 3-3-2b-c.* 7. Facilitator/educator will summarize how untreated sewage reaches Pashan lake and how it impacts the aquatic ecosystem. 8. They will ask students what they think people should do to reduce the quantity of pollutants in household wastewater, and what communities and municipal authorities should do to treat their wastewater. 9. Continue to 3-3-1d. **3-3-1c - Where does wastewater go** **30 mins** (at school) Illustration / drawing / mapping Facilitator/educator will facilitate the following for the students: ● Draw the school campus along with its building(s) and other features like open area, pathways, society, etc ● Mark locations on the campus map indicating water supply source, storage, water usage points and wastewater disposal points. This will help identify the different locations of water usage on the campus ● Use different colours to connect and indicate different stages of water use (treatment, supply, storage, usage, and disposal)

- On one side of the drawing sheet, make a list or drawings of water sources like borewell, well, community tank, pond, river, rain, water tankers, government water tap connection, and any others; draw a line connecting the sources the school gets water from to the pipe or water tank storage in the drawing of the school.
- Draw and mark the line of water disposal e.g pipe into sewage lines, pipe into storm drain, septic tanks, sewage treatment plant, garden, groundwater recharge, and other disposal, if present.
- Map your school, mark the above selected point and line into the map of the school you have made. Connect them with a line to indicate flow of water from water supply source to storage to usage to disposal point to river. If there is any reuse or recycling of water, remember to mark those on your map

Ask students:

- What are the different impacts of the used and sewage water that flows out from your school campus?
- What are the different plants, insects and animals on campus and how do they get the water they need to survive? Do they produce wastewater like we do? If not, how do they manage?

Refer to – Background content for facilitator/educator – section 3-3-2b-c.

3-3-1d - What can we do?

10 mins

	Facilitator/educator will share with students pictures or a list of actions we should take to manage wastewater. *Refer to – WC-3-3-Activity-II.* Facilitator/educator will ask students to categorize these into actions they can take individually at home, actions to be taken at a community level or city level. 1. Shift to natural cleaning agents for washing dishes and mopping the floor 2. Not throwing used oil, used tea leaves or food waste in the kitchen sink 3. Adopt simple practices for re-using wastewater at home if possible, such as water used for washing vegetables to be used for watering plants 4. Treat wastewater in a community sewage treatment plant 5. Set up a soak pit for a household toilet if there is no sewage network in the neighbourhood 6. Recover resources from wastewater, such as phosphates and nitrates for fertilizer for plants 7. Organizing regular clean-up drives at a nearby stream/ river 8. Avoiding the use of plastic bags so that they do not end up as litter 9. Always segregating dry waste at home and giving it for recycling 10. Speak up about water issues, such as writing to the Mayor or Municipal Commissioner about untreated sewage in the city and requesting for proper infrastructure to be set up for

	wastewater management. 11. **3-3-1e - Extension for 3-3-1d** **20 mins** Encourage students to plan any wastewater management actions they may like to introduce at home, such as composting, and using natural cleaners. If the students are interested, guide them to write a letter to the Municipal Commissioner highlighting the need for increasing wastewater treatment facilities and stream rejuvenation in Pune. *Refer to – WC-3-3-Activity-III.* **10 mins** Facilitator/educator will randomly select 5 students and discuss the answers to WC-3-3-Activity-II and III. They will fill in any gaps in understanding the session.
Differentiation	The activities for this session will vary depending on the location where the session is conducted and the interest and initiative taken by the students.
Additional activities	--
Anticipated challenges and solutions	Identifying the wastewater system at the school campus. Water hyacinth is being removed at Pashan Lake so it may not be evident that the lake is polluted with sewage and run-off; some water hyacinth is likely to be present at the barrage (where the lake water flows out into the Ramnadi). The facilitator should check the best location for explaining sewage inflow and water hyacinth growth at the lake site.

Keywords	Wastewater, treatment, nutrient, invasive, exotic, pollutant, algal bloom, water hyacinth, acquatic ecosysytem, ecosystem balance, wastewater recycling, wastewater reuse

3-3-2 Background content for facilitators/eduators

The textbook chapter is well written and comprehensive for the middle school level.

NCERT, Class 7th, Chapter 18

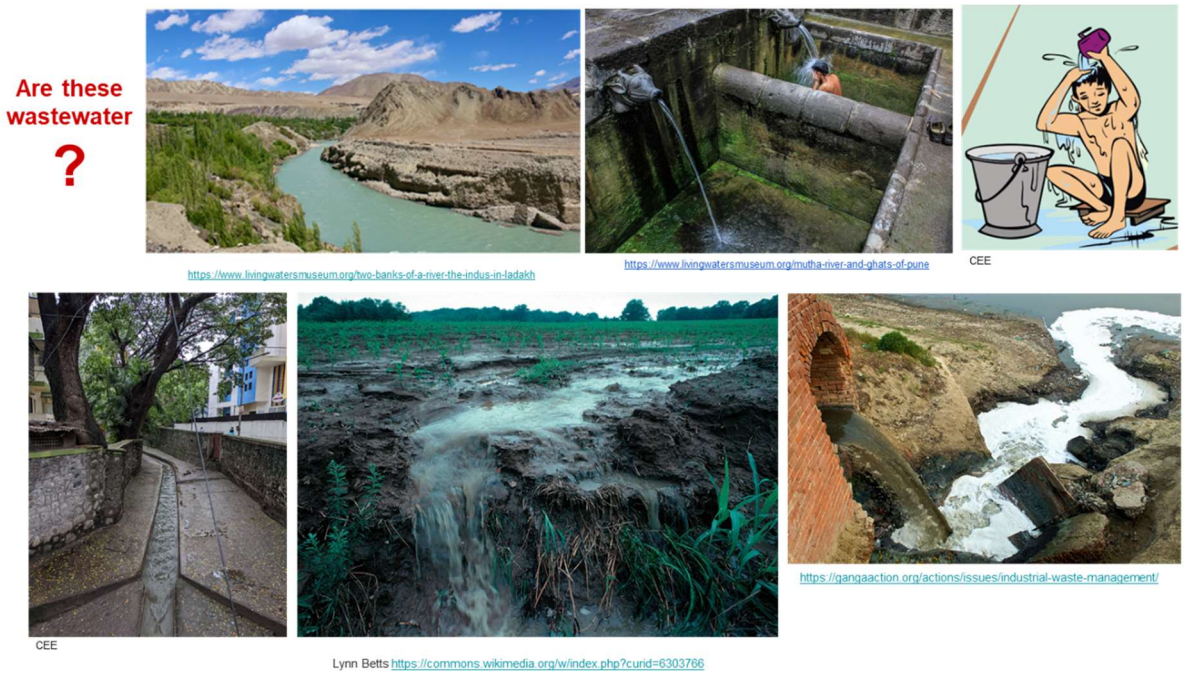
3-3-2a What is wastewater

Wastewater is the "used water" that has been used by people in their homes, schools, offices and factories.

It includes:

- Domestic wastewater from homes, offices, schools, restaurants, such as the water left over after washing utensils and clothes, mopping the floor, bathing, toilet, etc. Domestic wastewater has human waste, leftover food particles, soaps, oils, cleaning chemicals. Wastewater from homes, schools and offices is called **sewage**.
- Industrial wastewater is the discharge from factories and industries. In factories, the water used for processing and manufacturing goods may include different dissolved or suspended chemicals, grease, etc. Wastewater from factories is called industrial sewage or **effluent**.

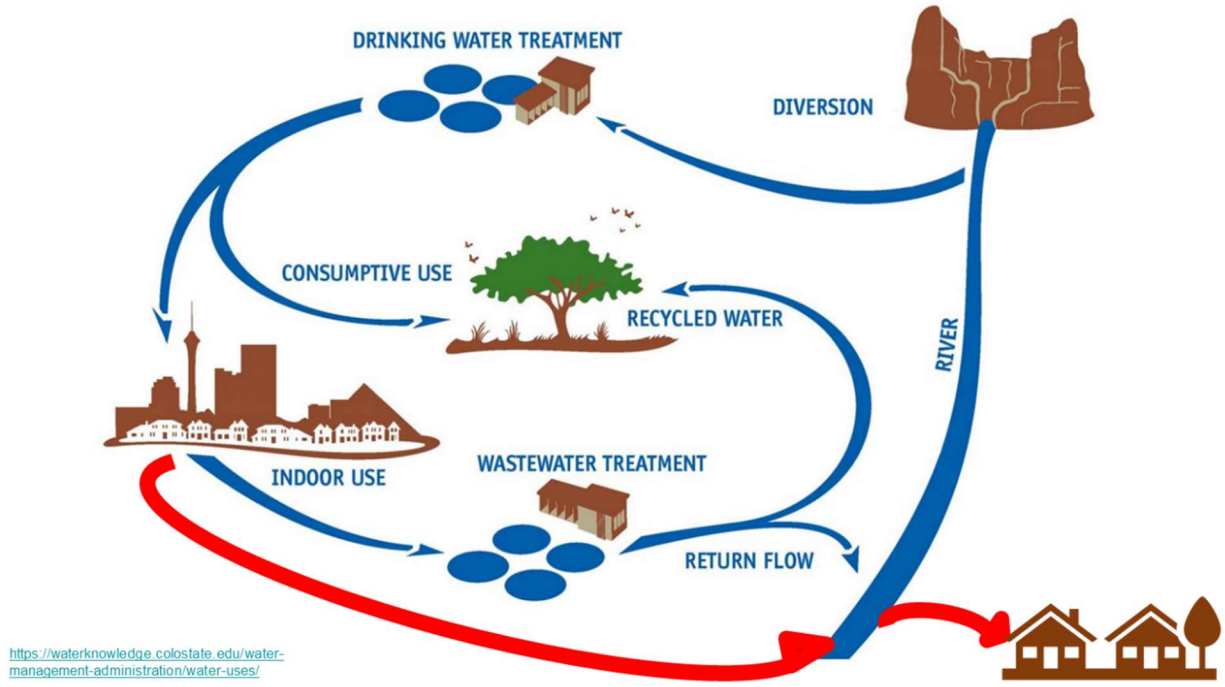
Some of these pollutants cannot be detected with the naked eye, while others drastically modify the composition of water affecting the taste, smell and appearance.



3-3-2b Where does wastewater go?

After we use water, the wastewater has to flow on, otherwise a pool of used water may form near our houses and in the neighbourhood. Where does wastewater go?

In villages or where the houses are not very close together and the quantity of wastewater is not very much, people may dig a ditch or drain to take away the used water. In cities, pipes may be used to carry away used water into a nallah or river. Thus we draw water from a pond, river, well or bore-well, use it for our needs, and then the used water may be collected and allowed to flow back into the earth, or a nearby waterbody.



3-3-2c Wastewater treatment

Wastewater may have harmful microorganisms and chemicals that should be removed before the wastewater is reused or returned to waterbodies.

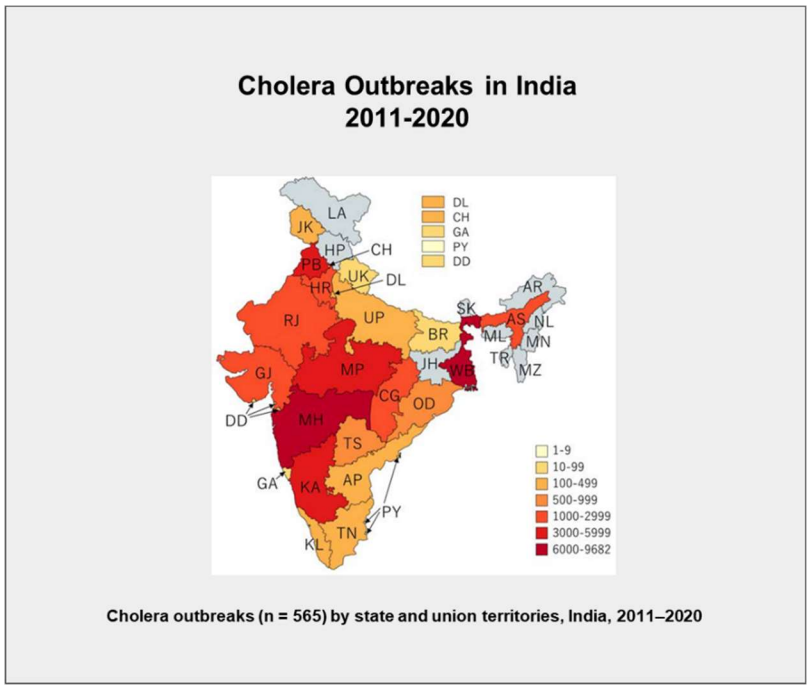
Read: How freshwater fish species in Pune rivers are being murdered by effluents.

The treatment of wastewater may include using *jaalis* or screens to remove solid wastes, such as plastics and cloth rags, gravity to settle suspended particles, oxygenation to promote decomposition of organic wastes, and use of chlorine, sunlight and / or ultraviolet light for disinfection and to remove harmful microorganisms.

Currently, in most villages and cities in India, the collection and treatment of wastewater is inadequate. In some cities, including some areas of Pune, wastewater is collected but not treated and is discharged directly into the ground or nearby streams and rivers without any treatment. This is a harmful practice as water polluted with sewage spreads infectious diseases, and disturbs ecosystems such as streams, rivers and lakes.

What happens if wastewater is not treated?

Some water-borne diseases that may spread due to untreated sewage are Cholera, Dysentery, Typhoid and Hepatitis A.



Source: Muzembo, Basilua Andre et al (May 2022) Cholera Outbreaks in India, 2011–2020: A Systematic Review

Read: [Water-borne epidemics in Khadakwasla dam chain, bacteria has increased 150 times in 15 years](#).

Panchayats, district and municipal authorities and citizens will need to make efforts to set up suitable systems for collection and treatment of wastewater.

What is manual scavenging, and why is it still prevalent in India?

Manual scavenging is the practice of removing human excreta by hand from sewers or septic tanks. India banned the practice under the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 (PEMSR).
(Representative image)
https://indianexpress.com/article/explained/explained-what-is-manual-scavenging-and-why-is-it-still-prevalent-in-india-7815400/

LOCALISING SDG'S NEWS

PMC launches robots to replace manual scavenging for sewer cleaning

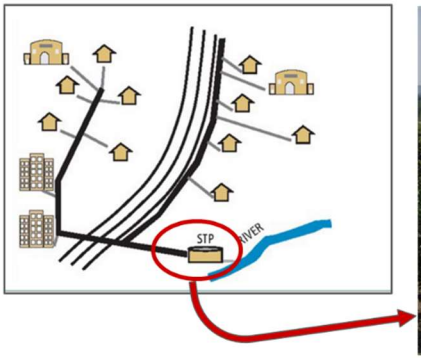
MAY 4, 2022 *by* TEAM URBAN UPDATE

PUNE, Maharashtra: The Pune Municipal Corporation (PMC) has introduced three advanced robots to clean and maintain manholes in the city safely without having workers entering them. The initiative has been launched to bring more safety to the maintenance of city manholes. Vikram Kumar, Commissioner, PMC, launched the robots at PMC on May 2.

https://urbanupdate.in/pmc-launches-robots-to-replace-manual-scavenging-for-sewer-cleaning/

Centralized waterborne waste disposal remains the prevalent method for sanitation and for evacuating wastewater from domestic, commercial and industrial sources. Globally, about 60% of people are connected to a sewer system (although only a small proportion of the collected sewerage is actually treated). Other sanitation options, such as on-site systems, are well-suited to rural areas and low population density settings but can be expensive and difficult to manage in dense urban environments.

Centralized sewage treatment

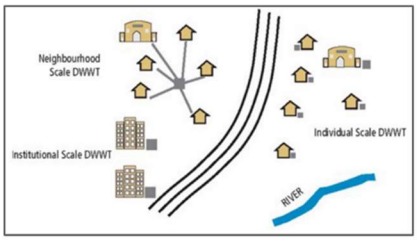


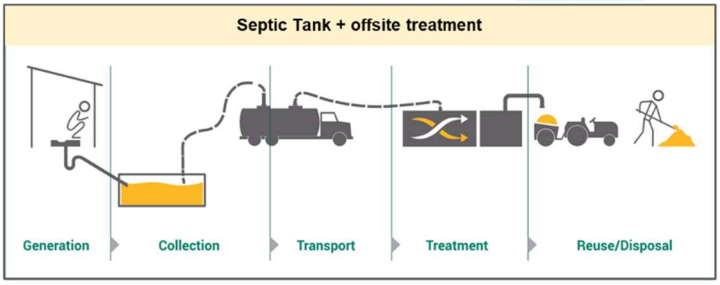
https://www.pmc.gov.in/en/image-gallery/album-images/377

Large-scale centralized wastewater treatment systems may no longer be the most viable option for urban water management in many countries.

Decentralized wastewater treatment systems, serving individual or small groups of properties, have shown an increasing trend worldwide. They allow for the recovery of nutrients and energy, save freshwater and help secure access to water in times of scarcity.

Decentralized sewage treatment





https://www.susana.org/_resources/documents/default/3-3221-153-1526713358.pdf

Watch: Build your own toilet

3-3-2d Wastewater can be a resource

Wastewater can be reused, and some of the wastewater we generate at home can be reused at the home itself. For example, water used for washing vegetables can be used for watering plants in a kitchen garden.

Sewage collected from homes, schools etc can be treated to remove harmful bacteria to provide:

1. Water that can be used again or let into natural water bodies
2. Nitrogen and phosphorus that can be used for making fertilizers
3. Other materials, depending on what the water was used for earlier

It is important to treat sewage and industrial effluent. Ponds, lakes, rivers, wells and groundwater may get polluted by untreated industrial effluent and domestic sewage.

An example of water pollution due to industrial negligence is the depletion of ground water

quality and quantity in the village of Plachimada in Kerala due to a multinational company setting up a soft drink plant in the village. The plant used to draw around 150 kilo liters a day and for every 3.75 liters of water used by the plant, 1 litre went into the final product and the remaining was thrown out as wastewater without proper treatment. Water samples collected from wells, hand pumps and open wells in the area were all contaminated with excessive levels of chromium, lead and cadmium.

3-3-2e Wastewater Management

Good practices for waste management include:

- Preventing pollution at the source, such as by
    - Not throwing used tea leaves and food scraps in the kitchen sink which add to the nutrient load (we may compost these instead)
    - Shifting to natural soaps and cleaning products
    - Avoiding use of harsh household chemicals
- Treating wastewater to remove contaminants, at the individual, neighbourhood or community level in small or mid-sized treatment plants, as locally appropriate
- Re-using the treated water for appropriate uses at the local level
- Recovering useful by-products from wastewater treatment

Together, these four actions contribute to health, human well-being, water and food security.

The connection of wastewater to many aspects of our lives is highlighted in Sustainable Development Goal 6 on water and sanitation, and especially Target 6.3 on halving the proportion of untreated wastewater and substantially increasing recycling, and safe reuse globally.

Instead of thinking about “treatment and disposal of wastewater”, we should encourage thinking and action for “reuse, recycle and resource recovery from used water”.

References/resources:

Sustainability and Water by Earthian, Wipro

Pune Municipal Corporation Sewerage Project

https://www.pmc.gov.in/sites/default/files/project-glimpses/STPs_of_Pune_0.pdf

Climate change: Untreated sewage major contributor

V. Nilesh, 25 July 2017, Climate change: Untreated sewage major contributor. The New Indian Express, Hyderabad.

Jeevitnadi (u.d). *Toxin Free Lifestyle*

https://www.jeevitnadi.org/make-your-own-family-starter-kit/

Story of Pashan Lake and Ramnadi

https://punyachepaani.livingwatersmuseum.org/story/ramnadi-pashan-lake/

Water Classrooms WC-3-3-ACTIVITY-I

Student Name: Class: Date:

Match the Following

Activity	**Materials in the used water**
1. Bath and toilet	A. Detergents
2. Run-off from fields	B. Food scraps and dish washing soap
3. Washing kitchen utensils	C. Fertilizers and pesticides
4. Washing clothes	D. Body wastes and soap

Water Classrooms WC-3-3-ACTIVITY-II

Student Name: Class: Date:

Read the practices listed below. Which of these practices can you adopt at home? Similarly, which practices may be done best at the community or city level? Write your answer in the column to the right.	
Activity	Home/ Community/ City
1. Shift to natural cleaning agents for washing dishes and mopping the floor.	
2. Not throwing used oil, used tea leaves or food waste in the kitchen sink.	
3. Adopt simple practices for re-using wastewater at home if possible, such as water used for washing vegetables to be used for watering plants.	
4. Treat wastewater in a community sewage treatment plant.	
5. Set up a soak pit for a household toilet if there is no sewage network in the neighbourhood	
6. Recover resources from wastewater, such as phosphates and nitrates for fertilizer for plants.	
7. Organize a clean-up drive at a stream.	
8. Avoid the use of plastic bags, segregate dry waste at home and give for recycling so that they do not end up as litter in waterbodies.	

Water Classrooms WC-3-3-ACTIVITY-III

Student Name: Class: Date:

Writing a formal letter to the Mayor or Municipal Commissioner expressing your concern about untreated sewage in the city, giving reasons for why proper wastewater management systems should be set up and also mentioning the actions you would take on your own as a citizen.