



Land Use Decision Makers and Their Roles in Drinking Water Protection Lesson: 11

National Science Education Standards for Grades 9-12

Content Standard A: Abilities Necessary to Do Scientific Inquiry

- *Communicate and defend a scientific argument.*

Content Standard F: Science in Personal and Social Perspectives: Environmental Quality

- *Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political and religious views and different ways that humans view the earth.*

Content Standard F: Science in Personal and Social Perspectives: Science and Technology in Local, National, and Global Challenges

- *Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land use—which decreases space available to other species—and pollution—which changes the chemical composition of air, soil, and water.*

Student Learning Objectives

- 11.1 Define what people mean when they use the term “land use decision maker.”
- 11.2 Describe how land use affects availability and quality of sources of drinking water.
- 11.3 Cite examples of actions land use decision makers can take to protect drinking water resources.

**Teacher Info
Table Time**

Instruction time for this lesson: 135 minutes (allow 90 minutes for activity SW.11.1.A)

**Resources,
Tools, Equipment
and Supplies**

11.1 Define what people mean when they use the term “land use decision maker.”

Resources

- SW.11.1.TM.B. slide, Who are land use decision makers?

Supplies

For Activity SW.11.1.A

4 flags, stakes or chairs

40-45 feet of rope, ribbon or twine

1 cardboard “road” (6” x 12’)

4 cardboard or wood “farms” (8 ½” x 11”)

6 cardboard or wood “houses” (8 ½” x 11”)

5 cardboard or wood “businesses” (8 ½” x 11”)

1 cardboard or wood “school” (17” x 22”)

1 cardboard or wood “factory” (36” x 32”)

1 cardboard or wood “highway shop, land fill site or county office building” (36” x 32”)

1 length of blue cloth (20 feet x 12”)

11.2 Describe how land use affects availability and quality of sources of drinking water.

Resources

- SW.11.2.TM.A, Land Use Effects On Drinking Water
- SW.11.2.AS handout, CAREER EMPHASIS – Urban and Regional Planners for each student
- Protecting Drinking Water Sources: Aligning Land Use and Source Water Protection, The Trust for Public Lands, <http://www.landuseandwater.org/>
- Effects of Urban Development on Floods, USGS Fact Sheet 076-03, <http://pubs.usgs.gov/fs/fs07603/>
- Why is this house wearing stilts?, USGS Water Science for Schools, <http://ga.water.usgs.gov/edu/impervious.html>

Resources, Tools, Equipment and Supplies

11.2. Resources (*continued*)

- What are the benefits of less paving?, NOAA Alternatives for Coastal Development, <http://www.csc.noaa.gov/alternatives/impervious.html>
- Impervious surfaces and the Hydrologic Balance of Watersheds, U.S. EPA, Watershed Academy, <http://water.epa.gov/learn/training/wacademy/07set.cfm>
- Locate Your Watershed, USGS, http://water.usgs.gov/wsc/map_index.html
- State Geological Surveys, Association of American State Geologist, <http://www.stategeologists.org/index.php>
- *Finding and Ordering USGS Topographic Maps*, U.S. Geological Survey, http://topomaps.usgs.gov/ordering_maps.html
- *Make a Contour Map: How Does a Contour Map Show Elevation?*, National Geographic, <http://education.nationalgeographic.com/education/activity/make-contour-map/Mapping>, National Geographic, <http://education.nationalgeographic.com/education/mapping/>
- *Forest and Drinking Water, Watershed Forestry Resource Guide*, Center for Watershed Protection and the U.S. Forest Service, <http://www.forestsforwatersheds.org/forests-and-drinking-water/>
- *Forests, Water and People: Drinking water supply and forest lands in the Northeastern and Midwest United States*, Northeastern Area, U.S. Forest Service, http://na.fs.fed.us/pubs/misc/watersupply/forests_water
- *Forests to Faucets*. The U.S. Forest Service has a comprehensive series of maps that illustrate the crucial role forests play in sustaining the watersheds that are most important to the quality of American surface drinking water. The Forests to Faucets interactive maps also identify the extent to which those watersheds are threatened by development, fire, insects and disease. Communities can use the data to help determine the important role their forests play in providing clean drinking water to urban areas. http://www.fs.fed.us/ecosystemservices/FS_Efforts/forests2faucets.shtml

**Resources,
Tools, Equipment
and Supplies**

11.3 Cite examples of actions land use decision makers can take to protect drinking water resources.

Resources

- SW.11.3.TM slide, *Land Use Decisions and Watershed Considerations*
- *Your Water. Your Decision: A Quick Guide for Community Leaders Committed to Safe Drinking Water*, Source Water Collaborative, <http://www.sourcewatercollaborative.org>, <http://www.yourwateryourdecision.org/media/download/OfficialsGuideV14.pdf>
- *Exploring Environmental Issues: Places We Live*, Project Learning Tree, www.plt.org/places-we-live
- *Source Water Collaborative Guide For Land Use Planners*, http://www.sourcewatercollaborative.org/downloads/PlannerGuide_23members.pdf,

Supplies

Plain paper

Pencils for drawings

Key Terms

Impervious surface

Land use decision maker

Open space

Pesticide

Septic systems

SUMMARY OF CONTENT AND TEACHING STRATEGIES: (BACKGROUND FOR EDUCATORS)

Land use effects on drinking water

Each time the use of a land area changes, it can affect the hydrologic makeup of the landscape. Examples of land uses and their effects on source water:

- Septic systems (a system used by many rural and suburban homes to dispose of sewage) – may contaminate groundwater
- Pet waste – infiltration to groundwater and potentially runoff to surface waters due to rainfall on gardens and lawns
- Fertilizer application – runoff of nitrogen and phosphorus to surface waters or infiltration to groundwater
- Stormwater runoff – runoff of gasoline, oil, automotive fluids and many other contaminants, to surface water or infiltration to groundwater
- Vehicle washing – Oil, degreasers, antifreeze may enter drinking water supply through rinse water infiltrating to the groundwater or running off to surface water
- Cropland (agriculture)—nitrogen and phosphorus pollution from fertilizer and pesticides can be delivered to ground and surface water
- Livestock and Poultry facilities – sources of nutrients, pathogens, pharmaceuticals from manure, litter and dust
- Timber harvesting – sediment and attached petroleum materials can runoff to surface water or infiltrate down into groundwater
- Recreation – related areas (such as ski slopes, hiking trails, golf courses, and marinas) also have the potential to directly or indirectly impact the both groundwater and surface water with high fertilizer or pesticide applications and heavy rainfall causing runoff or infiltration
- Commercial or residential development—if not properly controlled, runoff from development sites can add sediment and other contaminants to local streams, lakes and rivers
- Paved surfaces (such as sidewalks, parking lots, roads and driveways—these surfaces can add contaminants such as oil and increase the volume of stormwater runoff, which can severely erode stream banks.

Land Use Decisions and Source Water Impacts¹

Communities throughout the U.S. are growing and changing. The changes that growth brings can have both positive and negative impacts. A community's natural resources are assets that are negatively impacted by growth if careful planning and proactive steps are not taken.

Land Use Decisions Can Affect Natural Resources and Water Quality

Land use decisions are having significant impacts on our water and other natural resources in communities across the country. The potential negative impacts to our water and natural resources increase as the intensity of land use increases.

Intensity of land use can be categorized as low intensity (open space including farmland, wild lands, and managed green space) or high intensity (industrial, commercial, and urban centers). More intensively developed areas have a greater level of impervious surfaces (such as roads, parking lots, sidewalks, rooftops) than low intensity areas. Impervious surfaces prevent natural infiltration of water and increase storm water runoff.

As the intensity of land use increases, infiltration and the ability to recharge groundwater decreases because percolation of surface water into the aquifer is inhibited. The increased runoff that results can also lead to increased water pollution and physical damage to our aquatic systems. Lands providing natural resources are often removed from this purpose and developed. Remaining wild lands adjacent to intensive land use are negatively affected, and some of the natural functions they provide (habitat and travel corridors) can be impaired.

Although agriculture may be categorized as a "low intensity" land use, it can greatly modify the landscape and drainage of the land, which can cause significant water quality impairments.

Lands Providing and Supporting Natural Resources

Loss of Open Space

Each year, more than 50,000 acres of farmland is converted to development in Indiana (according to the USDA's 1997 Natural Resources Inventory). This is equal to nine acres per hour – a trend in land use change that has a serious impact on the amount of prime farmland for future production needs. (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri>)

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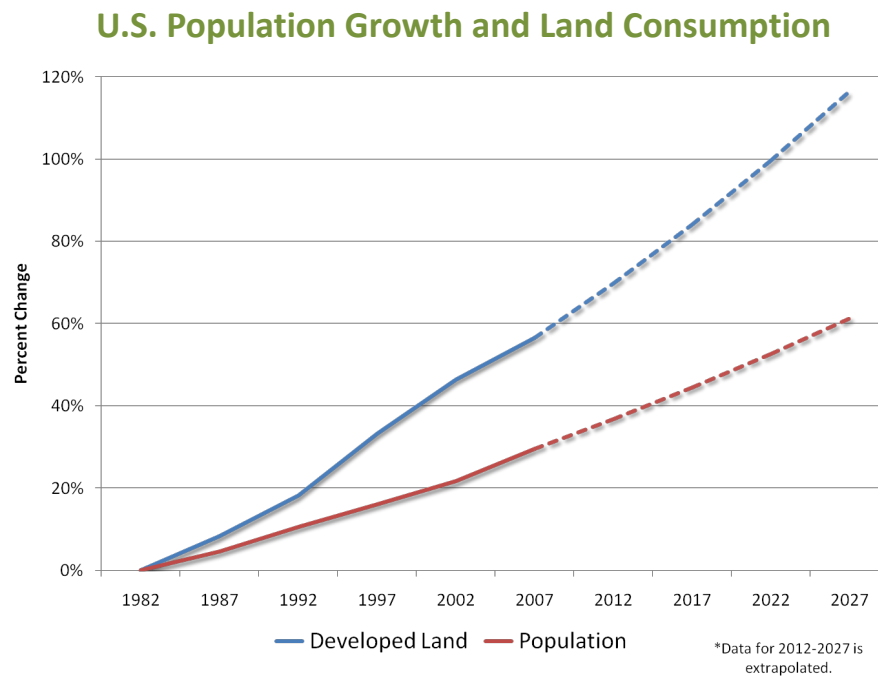
Adapted from *The Relationship between land Use Decisions and the Impacts on Our Water and Natural Resources, Planning with Power*, Purdue University Cooperative Extension Service Pub. #ID-260, IISG-01-19, http://www.planningwithpower.org/pubs/id_260.pdf

What is open space?

Open space includes farmlands, managed green space (golf courses, parks, recreation areas), and wild lands (such as forestlands, unmanaged habitats, field corners, fencerows and abandoned pastures). These areas perform many vital and important functions such as collecting and filtering our water, filtering our air, providing critical habitat for wildlife, providing places for recreational opportunities and providing food and fiber for the world. How these lands are managed affects our sources of drinking water.

Unfortunately, this open space is rapidly disappearing. From 1926 to 1997, the rate of development in the United States doubled to a level of three million acres per year.

Our natural resources are all produced in the “open space” on our landscapes. Land use changes permanently impact lands providing our natural resources and can negatively impact the quality of the remaining lands that provide natural resources or perform natural functions.



How do we want to use our land?

Natural resource-based planning is a process that identifies critical natural resources, evaluates potential impacts to these resources from proposed land use changes, and identifies practical strategies that can reduce the impacts on natural resources from land use change. Through this process, communities can effectively protect their valuable natural resources, such as farmland, forests, open spaces, drinking water sources, and wildlife habitat, and reduce the fragmentation of lands while still accommodating growth

in their community.

One of the most important elements in land use decision-making is the comprehensive land use plan for the community. The comprehensive plan answers three key questions for the community: What kind of growth? How much growth? Where should we put it? Comprehensive planning is a process where the local community develops a long-term vision of what kind and how much development it wants, then finds the balance between protection of natural resources and economic growth and development. The comprehensive planning process has to involve all segments of the public. Without public support and involvement, the planning process will not represent the entire community. A community that does not have a comprehensive plan, or a recently revised plan, is vulnerable to special interest groups. Development could occur in the community with little thought or concern for the resources that are unique and valuable to the area. Without a plan, severe degradation and loss of valuable natural resources will occur. Even with a comprehensive plan, it is important to look at a community's zoning regulations to see how they fit with the plan, and to see the long term impact of what is allowed - what will the community look like in 20 years under current zoning? What could be the impact on drinking water supplies?

To effectively protect the natural resources of a community, several key steps must be taken:

- Inventory the natural resources in the community.
- Prioritize areas for protection.
- Target development to the most appropriate areas.
- Incorporate open space planning.
- Develop a plan of action and revise zoning and subdivision regulations.

INTEREST APPROACH:

Lesson 11 takes a wide look at land use decision makers by involving students in a role-playing activity to experience the potential conflicts in land use planning. They identify local development that has the potential to impact drinking water quality and quantity.

A suggestion for getting started: Involve students in a personal reflection about the range of land use issues that appeal to their interests. There will be an opportunity to reflect in the review after the lesson.

What stores parks or playgrounds or other facilities do you wish we had in our community? (Prompt with ideas about clothing, sporting goods stores, skateboard parks, raceways, etc.)

OBJECTIVE BY OBJECTIVE:

Activity Outline and Teacher Support Information:

Many people are involved in decisions about land use that have the potential to affect water quality and quantity. Some of those decisions are made by individual homeowners, business leaders, farmers and others that are making personal decisions about lawn care, pet wastes, septic maintenance, waste disposal, cropping and manure management practices, and other actions that can affect local source water. There is another group of decision makers that make choices about land use for the community as whole. This is the group of land use decision makers that will be the focus of this lesson.

Students should read handout SW.11.AS, *Land Use and Source Water Impacts*, in preparation for lesson activities.

11.1. Define what people mean when they use the term “land use decision maker.”

All local decision makers, whether elected or appointed officials, volunteer committee members, or staff, face difficult questions about how to meet community needs for housing, public infrastructure, and economic development. When planning for community needs, they must also consider other important community assets or components such as the need for open space, sites of historical significance, and sensitive cultural and natural resources. Land use conflicts are common, and in many states some of the most difficult cases involve wetlands, groundwater and surface water issues.²

In this activity students will explore the meaning of the term “land use decision maker” through a role playing activity and an in-depth look at the role of a land use planner.

² Adapted from *Land Use and Wetlands: A Local Decision makers' Guide to Wetland Conservation*, Wisconsin Wetlands Association, http://www.wisconsinwetlands.org/LocalDecisionMakersGuide_print.pdf

SW.11.1.A**Creating My Hometown: An Exercise in Land Use Decision Making³****INTRODUCTION**

In addition to highlighting the roles of land use decision makers, this activity is designed to:

1. Provide a hands-on decision making exercise in land use development for the participants.
2. Enhance the knowledge of participants concerning land use conflicts by allowing them to role-play and make their own decisions.
3. Increase the understanding of conflicts in society that arise with land use planning by requesting each participant's decision to be explained.
4. Encourage the participants to understand that land use conflicts will continue to arise and that someday the participants might find themselves in a decision-making role.
5. Provide an avenue to highlight land use decisions that affect local drinking water quality and quantity.

Through this role-playing exercise, students will make land use decisions and provide a rationale for those decisions. At the conclusion of the exercise, participants will have an improved understanding of the complexity of land use decisions.

The class participates in this 40-45 minute activity as a group. All students play a role and are actively engaged in the process.

You will introduce the class to a 10' x 10' outdoor area and tell them it represents 10 square miles of undeveloped land. You will then tell them that the area will soon be experiencing rapid growth and development. Then, let the role-playing begin!

³ Creating My Hometown: An Exercise in Land Use Decision Making http://www.uwex.edu/ces/cced/communities/documents/MyHometown_final.pdf

PREPARATION

Materials needed:

- 4 flags, stakes or chairs
- 40-45 feet of rope, ribbon or twine
- 1 cardboard “road” (6” x 12’)
- 4 cardboard or wood “farms” (8 ½” x 11”)
- 6 cardboard or wood “houses” (8 ½” x 11”)
- 5 cardboard or wood “businesses” (8 ½” x 11”)
- 1 cardboard or wood “school” (17” x 22”)
- 1 cardboard or wood “factory” (36” x 32”)
- 1 cardboard or wood “highway shop, land fill site or county office building” (36” x 32”)
- 1 length of blue cloth (20 feet x 12”)

1. Lay out an area 10’ x 10’ square using the rope, ribbon or twine. Use the stakes, flags or chairs to mark the square. This designated space represents the 10 square mile planning area.

You or other designated facilitator ask or appoint different participants to make land use decisions. The first decision maker is asked where a major road should be placed and to provide a rationale for the location that is selected. That decision is followed by the placement of different land uses, such as agriculture, residential, commercial, institutional, industrial, and governmental. As the decisions become more complex, more probing questions are asked which will reveal potential land-use conflicts and the complexity of land use planning.

2. Introduce the participants to the exercise by indicating that it is an interactive activity, which means that they do all the work and you ask all the questions! Further indicate that everyone will get an opportunity to participate by taking on a specific planning role, either by appointment or by volunteering. Tell them that the roped off area represents 10 square miles of undeveloped land and that they will be responsible for all the planning in this area.
3. Select three (or less, depending on the size of your group) volunteers to be “transportation engineers.” Give them the task of locating the “road” anywhere in the 10 square miles, as long as it is one straight line. (Remember: Engineers like straight roads!) Once the road is placed, each engineer will be asked questions, such as:
 - Why did you locate there?
 - What weight limitations does the road have?

- Will that accommodate tractors?
- What's the speed limit?
- How many cars a day use it?
- Does the road cross wetlands?
- Will salts from the road run off into local drinking water sources?

Once this is done indicate to the group that they have just dealt with a transportation use. Other transportation uses could include airports, railroads, bicycle trails or the location of a bus depot. Try to encourage use of local, relevant examples.

4. In this step, ask for four volunteers and give them the task of locating their “farm” someplace in this same 10 square mile area. Once this is done, ask the “farmers” a variety of questions, such as:

- What type of farm do you have?
- How many animals do you have?
- How many acres do you own?
- What crops do you raise?
- What are your average production levels per acre?

You could get very creative with the questions. For example, if a participant indicated they had a hog farm, you could ask if it is a feeder operation, a farrowing operation, a farrow-to-finishing operation, or a finishing operation.” This will give the participants a very real sense of how complex-farming operations can be. It is also important to point out that many times decision-makers are not intimately familiar with all aspects of the land use decisions that they need to regulate. The participants who are role playing as farmers will typically identify dairy, beef, swine, crops or vegetables as being their primary focus. To conclude this discussion, explain to the group that though these are different enterprises they are all agricultural uses.

5. Now select or appoint four to six volunteers to be homeowners. Instruct them to place their \$250,000 homes someplace in the 10 square miles (the price should be high enough to reflect upper scale homes in your area). They can place their dwellings anywhere except on the road or in the area already designated as agricultural. After the homes are placed in the area, you can ask questions such as:

- Why did you locate here?
- What type of occupation do you have to be able to pay for this house?

- Do you need to get to work every day?
- What is the source of your drinking water for humans (and for animals—for farmers)?
- Does your house have a septic system or is it connected to the town system?

Some potential responses could include:

- I located here because I want to
- To live close to a farm
- To be able to recreate on my land, or to have a water view
- To have privacy
- To be close to my work
- To be close to my neighbor or friend

After each person has shared their reason, you can share your observations about potential sprawling development; potential difficulties in providing public services such as water, garbage pickup, snow removal, road maintenance, emergency services or police protection. Discuss the high cost of providing these services to residents located throughout the plated area. Indicate that the participants have now dealt with residential use.

6. Next select four to five participants to be “entrepreneurs” or business people. Allow the participants to place their businesses anywhere in the ten square miles (except on the road, farms or homes). After the businesses are placed in the area, ask the participants, questions like:

- What type of business is it?
- Why did you locate here?

Potential responses could include:

- Advertising reasons
- Easy access to roads and/or water
- The land was cheap
- Nice mix of homes
- The service was needed here

At this point, ask several homeowners if they like where this business is located and why. You may want to do the same with a farm or two. Indicate that this is a commercial use and emphasize the potential conflict between uses that may have been indicated.

7. Now appoint or select two or three participants to be newly elected members of the school board. Emphasize that their first responsibility is to find a location for a new school. They are allowed to place the school anywhere in the ten square miles but not on a business, a home, a farm or the road. After the school has been located, ask a combination of the following questions:

- Why did you place the school there?
- What type of school is it?
- How many students do you have?
- How many teachers do you employ?
- How will students get to school?

Possible responses could include:

- We wanted to locate it close to the road for transporting students
- We wanted it to be close to homes where students live
- This was close to the middle of the area
- The land was cheap
- It was located close to teachers or services

Ask a business or two if they like where the school is located. Do the same for the homeowners and farmers. At this point some very distinct conflict generally occurs. Explain that all schools are institutional uses. Other institutional uses could include prisons, universities, colleges or hospitals.

8. Next select three to four participants to be on the board of directors of a start-up industry, which plans to locate in the ten square mile area. Instruct the board that they can place the factory anywhere in the ten square miles but not on the road, homes, businesses or the school. Once the factory is located, ask different board members questions like:

- What products are they producing?
- Why did they select this location?
- How many people do they employ?
- Will this company/factory have discharger that might have an impact on water or air quality?

Possible responses could include:

- The location is close to a major road or water source
- There is room for expansion
- The land was cheap
- There wasn't much development in this area
- The location was close to the labor supply

Now ask two farmers, homeowners, business people or school board members if they like where this factory is located. This generally creates a tremendous amount of conflict, and you may have to cut off the discussion and move on. Explain that they have just dealt with an industrial use and that citing these types of uses can be very controversial. At this point in the exercise (if you have time) you could add a different set of questions for the board of directors such as:

- Are your employees unionized?
- What is your base salary per hour?
- Do you have smoke stacks?
- How many?
- Do they have EPA approved scrubbers?
- Do you have wells?
- How many?
- Are they high capacity wells?

9. Now select four to six participants to be members of a county board committee. It could be a highway, property or solid waste committee, depending on the type of structure to be placed. Identify the task as one of locating a public service (this could be a solid waste land fill site, a new highway shop, or new county office building). This group can place this use on a farm, home, or business, but no other land uses. At this point in the process there is very little space open and usually a house or farm or business needs to be covered, or replaced by this public use. If this occurs, you need to explain that local units of government have the power of eminent domain, which allows them to condemn private property and pay "fair market" value for the property, if its use change better serves society (for example public utilities, highways, railroads, or for uses related to public safety). Next ask the county board members:

- Why did you locate it there?

Possible responses could include:

- Proximity to road
- Open space
- Cheap land
- Least amount of development
- It was the only place left to develop

Ask representatives from the different land uses if they agree where this land use was located. Generally there is considerable disagreement and conflict with this land use. Explain that this is a governmental/public use and it is often very controversial.

10. If time permits, you may want to ask, Do you feel this was an organized approach to addressing development? The answer is usually “NO.” You can further the discussion with another question like, “But isn’t this the way that development usually occurs in your area? The answer is usually, “YES.” Now you can ask the question, if we wanted to look at a development plan that has less controversy, where would we start first? Generally, the group starts with roads and work their way back from more controversial to less controversial land uses. In other words they think about how conflict in land use planning could be reduced. For more mature audiences complete this exercise with a discussion on how comprehensive land use planning is an important tool for minimizing conflict and serving the broad interests of the public.
11. If time allows, introduce a couple of other land use concepts, such as forestry and recreation. These could also be substituted for farms if your community doesn’t have many agricultural uses. They could also be incorporated at the end of the activity as other types of “open” space land uses and explain why. At the close of the session you can ask the students to identify the different land uses that were discussed. They would be transportation, agricultural, residential, commercial, institutional, industrial, governmental, forestry and recreational.
12. Now ask each group of stakeholders, in this 10 square miles which of the land uses and use activities discussed have the potential to impact the quality and quantity of drinking water in your community? What concerns does each user group have? Ask the students to note these responses in their journals.

Digging Deeper: Examining the Roles of Planners in Land Use Decision Making

Make copies of SW.11.2.AS handout, *CAREER EMPHASIS – Urban and Regional Planners* for each student. Give each student a copy and ask students to read them in class or as a homework assignment. Display slide SW.11.1.TM.B, *Who are land use decision makers?*, and discuss content of slide and handout with students. Using an LCD projector with Internet feed, find your county or municipal planning department's website. Ask the students to guide you through the site to learn the roles and names of local land use decision makers.

11.2. Describe how land use affects availability and quality of sources of drinking water.

Many land use decisions can impact drinking water quantity and quality. Ask students to brainstorm a list of land uses that have the potential to impact drinking water resources in their rural community. Create a list of their ideas on the board. Then show slide SW.11.2.TM.A, *Land use effects on drinking water*, identify those uses that could be added to the students' list. Which of the uses on their list are related to runoff? In this activity, students will focus on *increased runoff* as a result of land use decisions.

In previous lessons, students explored the causes of polluted runoff and how it affects water resources. In this activity they will investigate how problems from runoff relate to land use decisions.

Scientific studies show a corresponding increase in the amount of impervious surfaces such as roads, parking lots, sidewalks and rooftops as the intensity of land use increases. An increase in impervious surfaces causes the volume and velocity of storm water runoff to increase significantly. The results can be increased flooding, severe erosion and physical degradation of stream and river habitats that adversely impact the entire watershed and our valuable water supply.

Studies have shown that streams in watersheds with greater than 10 percent of their land area in impervious cover begin to show signs of ecological impairment. As the impervious cover in a watershed approaches 25 percent, streams become degraded and the water quality, habitat quality, and biological diversity occurring in watershed streams are all greatly reduced.

Flooding can have disastrous impacts on the local community, both in terms of private property damage and use of public tax dollars for clean up and removal of debris and sediment when floodwaters recede. Erosion of our valuable topsoil resource can result in decreased agricultural productivity and increased sediment runoff. Sediment runoff may contain nitrogen and phosphorus pollution as well as pesticides, which can all degrade water quality.

For this activity you will need a copy of a topographic map for your community. Maps can be ordered from the U.S. Geological Survey, http://topomaps.usgs.gov/ordering_maps.html. Check with a natural resource professional or your state geological survey (<http://www.stategeologists.org/index.php>) if you need help finding a topographic map. Make an outline of the local watershed(s) on the topographic map. To find the boundaries of your watershed, go to *Locate Your Watershed*, USGS, http://water.usgs.gov/wsc/map_index.html.

Ask students to identify areas in their community that have the largest amount of impervious surfaces, such as a mall, a box store, a church or their school. Have students describe the type of impervious surface for each, such as parking lot, roof, roadways or sidewalks. For each example ask them to identify, from a local topographic map, the body of water to which that surface drains as well as the name of the watershed in which it is located. Answers should be written in their journals. Have them note in their journals what types of contaminants might be carried into that body of water from the identified surfaces.

11.3 Cite examples of actions land use decision makers can take to protect drinking water resources.

In the publication, *Your Water. Your Decision*, the Source Water Collaborative gives the following advice to decision makers:

How you govern can determine what you drink. Consider your community's efforts in these key areas: development patterns, pricing options, and stewardship.

Here's what they have to say about development patterns:

Planning land use at the watershed level protects sources of drinking water by conserving and protecting land where development would harm source water. Consider promoting development in already developed areas or in less environmentally sensitive areas. Consider:

More green space. Preserving open space helps protect drinking water sources, especially contiguous areas such as stream corridors, wetlands and recharge areas. Redevelopment and compact development can help preserve critical open space.

More natural vegetation. Preserving natural vegetation - especially within green space areas and along rivers and lakes - lowers pollution. Planting new trees and vegetation also reduces runoff.

Less pavement. Reducing impervious surfaces, such as pavement and concrete, through pervious paving materials, narrower streets, and parking decks, decreases runoff and recharges the groundwater supply. Development guidelines or incentives to promote green infrastructure can help.

Up-to-date local policies. Comprehensive plans, open space plans, low-impact development requirements, building permits and zoning tools can encourage development that protects drinking water supplies.⁴

The Collaborative offers the following advice about stewardship to encourage land use planners to see a wider picture:

A local government's own actions can set the tone for source water protection. Here are steps some communities have taken:

Efficient infrastructure. Roads, water and sewer systems and other public infrastructure can be designed and maintained to reduce runoff, pollution and water loss.

Think regionally. Drinking water sources don't stop at political boundaries. Partnering with neighboring communities can help ensure your water sources stay clean and abundant.

Expand monitoring. Checking stream and groundwater quality can give communities meaningful information about the state of their drinking water supply.

Behavior change. Some communities adjust services and reach out to citizens to influence individual behaviors that collectively have an impact on water use.

Be a role model. Local governments can demonstrate commitment to source water protection through actions such as recycling vehicle wash water, using alternative road treatments that reduce pollution and supporting community household hazardous waste collection.

Project slide SW.11.2.TM.C, *Land Use Decisions and Watershed Considerations*. Provide students with plain paper and pencils. Ask them to choose one of the facilities with a large impervious surface, they identified in Activity 11.2 and make a quick sketch of an outside view of that facility. Have them choose one of the development suggestions from the slide to implement at their facility. Then ask them to draw how they envision that change at the facility. For instance, if they choose to install treatment wetlands along the edges of the parking areas to retain stormwater, have them add that change to their drawing. Students could also identify an area of their watershed where conserving open space from future development would protect drinking water sources.

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Your Water. Your Decision: A Quick Guide for Community Leaders Committed to Safe Drinking Water, Source Water Collaborative, www.ProtectDrinkingWater.org, <http://www.yourwateryourdecision.org/media/download/OfficialsGuideV14.pdf>

REVIEW / SUMMARY:

Think back to the discussion we had at the beginning of this lesson. What kind of store or facility were you most interested in having in our community before the lesson?

In your journal, write three paragraphs about the pros and cons of building this here—one from your own perspective, and pick two of the following perspectives: existing business owner, entrepreneur, farmer or homeowner.

What are some of the water-related impacts of building in your community? Who would be involved in evaluation of the environmental impacts of building?

What are some areas in your community that could be preserved as open space to protect our sources of drinking water? Are there sensitive lands, such as wetlands, forests, floodplains and habitat that should be protected?

EVALUATION AND ANSWERS:

SW.11.ASSESS

Name two ways that increases in impervious surfaces can compromise source water quality.

Who makes decisions about where people can build commercial or residential structures in my community?

Name two steps that should be taken for a comprehensive land use plan.

Answers to SW.11.ASSESS

Name two ways that increases in impervious surfaces can compromise source water quality.

- They increase runoff
- They decrease water infiltration

Who makes decisions about building commercial or residential structures in my community?

- Land use decision makers of town, village, city or county:
- Boards of supervisors
- Boards of adjustments or appeals
- Planning, zoning and land conservation commissions or committees
- Town, village, city and county administrators and staff members
- Citizens interested in influencing local land use decision; citizen advisory committees

Name two steps that should be taken for a comprehensive land use plan.

Any two of the following steps would be appropriate responses:

- Inventory the natural resources in the community
- Prioritize areas for protection
- Target development to the most appropriate areas
- Incorporate open space planning
- Develop a plan of action and revise zoning and subdivision regulations

ACTIVITY WORKSHEET(S) – AS NEEDED:**SW.11.1.AS****Land Use Decisions and Source Water Impacts⁵**

Communities throughout the U.S. are growing and changing. The changes that growth brings can have both positive and negative impacts. A community's natural resources are assets that are negatively impacted by growth if careful planning and proactive steps are not taken.

Land Use Decisions Can Affect Natural Resources and Water Quality

Land use decisions are having significant impacts on our water and other natural resources in communities across the country. The potential negative impacts to our water and natural resources increase as the intensity of land use increases.

Intensity of land use can be categorized as low intensity (open space including farmland, wild lands and managed green space) or high intensity (industrial, commercial and urban centers). More intensively developed areas have a greater level of impervious surfaces (such as roads, parking lots, sidewalks and rooftops) than low intensity areas. Impervious surfaces prevent natural infiltration of water and increase storm water runoff.

As the intensity of land use increases, infiltration and the ability to recharge groundwater decreases because percolation of surface water into the aquifer is inhibited. The increased runoff that results can also lead to increased water pollution and physical damage to our aquatic systems. Lands providing natural resources are often removed from this purpose and developed. Remaining wild lands adjacent to intensive land use are negatively affected, and some of the natural functions they provide (habitat and travel corridors) can be impaired

Lands Providing and Supporting Natural Resources**Loss of Open Space**

Each year, more than 50,000 acres of farmland is converted to development in Indiana (according to the National Resources Inventory). This is equal to nine acres per hour – a trend in land use change that has a serious impact on the amount of prime farmland for future production needs.

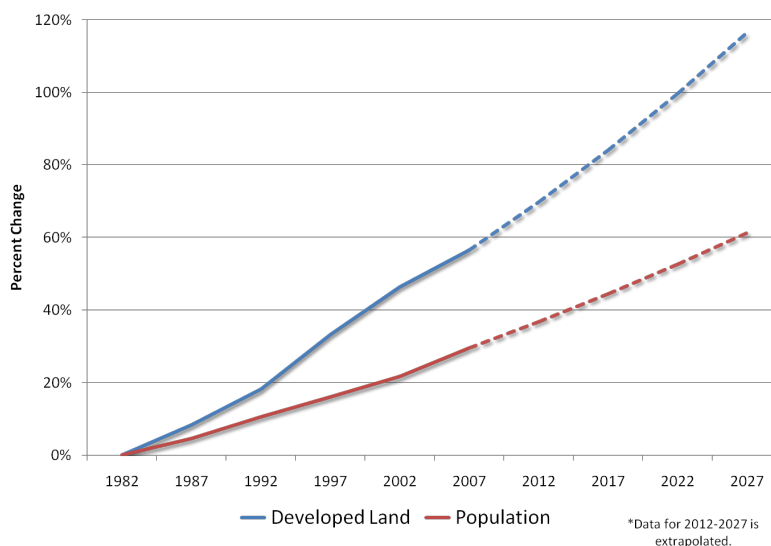
⁵ Adapted from *The Relationship between land Use Decisions and the Impacts on Our Water and Natural Resources, Planning with Power*, Purdue University Cooperative Extension Service Pub. #ID-260, IISG-01-19, http://www.planningwithpower.org/pubs/id_260.pdf

SW.11.1.AS *(continued)**What is open space?*

Open space includes farmlands, managed green space (golf courses, parks, recreation areas), and wild lands (such as forestlands, unmanaged habitats, field corners, fencerows and abandoned pastures). These areas perform many vital and important functions such as collecting and filtering our water, filtering our air, providing critical habitat for wildlife, providing places for recreational opportunities and providing food and fiber for the world. How these lands are managed affects our source of drinking water.

Unfortunately, this open space is rapidly disappearing. From 1926 to 1997, the rate of development in the United States doubled to a level of three million acres per year.

Our natural resources are all produced in the open space on our landscapes. Land use changes permanently impact lands providing our natural resources and can negatively impact the quality of the remaining lands that provide natural resources or perform natural functions.

U.S. Population Growth and Land Consumption***How do we want to use our land?***

Natural resource-based planning is a process that identifies critical natural resources, evaluates potential impacts to these resources from proposed land use changes, and identifies practical strategies that can reduce the impacts on natural resources from land use change. Through this process, communities can effectively protect their valuable natural resources, such as farmland, wetlands, forests, open spaces, and wildlife habitat, and reduce the fragmentation of lands while still accommodating growth in their community.

SW.11.1.AS *(continued)*

One of the most important elements in land use decision-making is the comprehensive land use plan for the community. The comprehensive plan answers three key questions for the community: What kind of growth? How much growth? Where should we put it? Comprehensive planning is a process where the local community develops a long-term vision of what kind and how much development it wants, then finds the balance between protection of natural resources and economic growth and development. The comprehensive planning process has to involve all segments of the public. Without public support and involvement, the planning process will not represent the entire community. A community that does not have a comprehensive plan, or a recently revised plan, is vulnerable to special interest groups. Development could occur in the community with little thought or concern for the resources that are unique and valuable to the area. Without a plan, severe degradation and loss of valuable natural resources will occur.

To effectively protect the natural resources of a community, several key steps must be taken:

Inventory the natural resources in the community.

Prioritize areas for protection.

Target development to the most appropriate areas.

Incorporate open space planning.

Develop a plan of action and revise zoning and subdivision regulations.

SW.11.2.AS

CAREER EMPHASIS – Urban and Regional Planners⁶

Urban and regional planners develop long- and short-term plans for the use of land and the growth and revitalization of urban, suburban and rural communities and the region in which they are located. They help local officials alleviate social, economic, and environmental problems by recommending locations for roads, schools and other infrastructure and suggesting zoning regulations for private property—work that requires forecasting the future needs of the population. Because local governments employ the majority of urban and regional planners, they often are referred to as community or city planners.

Local governments employ about 66 percent of urban and regional planners.⁷
U.S. Bureau of Labor Statistics

Planners promote the best use of a community's land and resources for residential, commercial, institutional and recreational purposes. They address environmental, economic and social health issues of a community as it grows and changes. They may formulate plans relating to the construction of new school buildings, public housing or other kinds of infrastructure. Planners also may help to make decisions about developing resources and protecting ecologically sensitive regions. Some planners are involved in environmental issues including pollution control, wetland preservation, forest conservation and the location of new landfills. Planners also may help to draft legislation on environmental, social, and economic issues, such as planning a new park, sheltering the homeless or making the region more attractive to businesses.

Before preparing plans for community development, planners study and report on the current use of land for residential, business and community purposes. Their reports include information on the location and capacity of streets, highways, airports, water and sewer lines, schools, libraries and cultural and recreational sites. They also provide data on the types of industries in the community, the characteristics of the population, and employment and economic trends. Using this information, along with input from citizens, planners try to optimize land use for buildings and other public facilities. Planners prepare reports showing how their programs can be carried out and what they will cost.

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Bureau of Labor Statistics, U.S. Department of Labor, <http://www.bls.gov/oco/ocos057.htm>
Bureau of Labor Statistics, U.S. Department of Labor, <http://www.bls.gov/oco/ocos057.htm>

SW.11.2.AS *(continued)*

Planners examine proposed community facilities, such as schools, to ensure that these facilities will meet the needs of a growing or changing population. They keep abreast of economic and legal issues related to zoning codes, building codes and environmental regulations. Planners also deal with land-use issues created by population movements. For example, as suburban growth and economic development create more jobs outside cities, the need for public transportation that gets workers to those jobs increases. In response, planners develop and model possible transportation systems and explain them to planning boards and the general public.

Planners use computers to record and analyze information and to prepare reports and recommendations for government executives, developers and builders. Computer databases, spreadsheets and analytical techniques are used to project program costs and forecast future trends in employment, housing, transportation or population. Widespread use of computerized geographic information systems (GIS) enable planners to map land areas, to overlay maps with geographic variables such as population density, and sources of drinking water, and to combine or manipulate geographic information to produce alternative plans for land use or development.

Urban and regional planners often work with land developers, civic leaders and public officials may function as mediators in community disputes, presenting alternatives that are acceptable to opposing parties. Planners may prepare material for community relations programs, speak at civic meetings and appear before legislative committees to explain and defend their proposals.

Most urban and regional planners focus on one or more areas of specialization, such as transportation planning, urban design, community development and redevelopment and land-use or code enforcement. While planners may specialize in these and other areas, they are also required to keep the bigger picture in mind and do what's best for the community as a whole.

POWERPOINT SLIDES – AS NEEDED:

SW.11.2.TM.A

Land use effects on drinking water

- Septic systems (a system used by many rural and suburban homes to dispose of sewage) – may contaminate groundwater
- Pet waste –infiltration to groundwater and potentially runoff to surface waters due to rainfall on gardens and lawns
- Fertilizer application – runoff of nitrogen and phosphorus to or infiltration to surface waters groundwater
- Stormwater runoff – runoff of gasoline, oil, automotive fluids and many other contaminants to surface water or infiltration to groundwater
- Vehicle washing – Oil, degreasers, antifreeze may enter drinking water supply through rinse water infiltrating to the groundwater or running off to surface water
- Cropland (agriculture)—nitrogen and phosphorus from fertilizer and pesticides can be delivered to ground and surface water
- Livestock and poultry facilities – sources of nutrients, pathogens, pharmaceuticals from manure, litter and dust.
- Timber harvesting– sediment and attached petroleum materials can run off to surface water or infiltrate down into groundwater
- Examples of other land-uses that have the potential to directly or indirectly impact the both groundwater and surface water
- Recreation areas: such as ski slopes, hiking trails and golf courses
- Parking lots, roads, driveways, sidewalks

SW.11.1.TM.B

Who are land use decision makers?⁸

Land use decision makers for town, village, city or county

Boards of supervisors

Boards of adjustments or appeals

Planning, zoning and land conservation commissions or committees

Town, village, city and county administrators and staff members

Citizens interested in influencing local land use decision; citizen advisory committees

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Adapted from *Land Use and Wetlands: A Local Decision makers' Guide to Wetland Conservation*, Wisconsin Wetlands Association, http://www.wisconsinwetlands.org/LocalDecisionMakersGuide_print.pdf

SW.11.1.TM.C

Land Use Decision and Watershed Considerations⁹

More green space. Preserving open space helps protect drinking water sources, especially contiguous areas such as stream corridors, wetlands and recharge areas. Redevelopment and compact development can help preserve critical open space.

More natural vegetation. Preserving natural vegetation - especially within green space areas and along rivers and lakes - lowers pollution. Planting new trees and vegetation also reduces runoff.

Less pavement. Reducing impervious surfaces, such as pavement and concrete, through pervious paving materials, narrower streets and parking decks, decreases runoff and recharges the groundwater supply. Development guidelines or incentives to promote green infrastructure can help.

Up-to-date local policies. Comprehensive plans, open space plans, low-impact development requirements, building permits and zoning tools can encourage development that protects drinking water supplies.

⁹ Adapted from *Your Water. Your Decision: A Quick Guide for Community Leaders Committed to Safe Drinking Water*, Source Water Collaborative, <http://www.sourcewatercollaborative.org>
<http://www.yourwateryourdecision.org/media/download/OfficialsGuideV14.pdf>