City of Bend
Stormwater Walking Tour
Points to Ponder Consideration Sheet

#1 Old Mill Parking Lot Near Theater/Bus Shelter

Q. Where do pollutants from roadways come from?

A. Several sources including automotive sources such as brake dust, leaks (oils, transmission fluid or antifreeze), atmospheric deposition of incomplete combustion, and lead wheel weights; road construction waste; spills and illegal dumping including trash. The hard impervious surface of the roadway increases the volume and velocity of runoff that can result in an increase in erosion over natural levels.

Q. How might using alternative transportation like buses, bikes, walking, etc. help protect stormwater quality?

A. It reduces the need for large parking lots and reduces the number of vehicles on the roadway along with the associated automotive sources of pollutants.

Q. Where does rainwater or snowmelt go?

A. It flows across the parking lot surface to catch basins and then into pipes that flow into a detention pond near the river. These ponds provide natural treatment and can overflow into the Deschutes River. Oftentimes in Bend, storm drains will either be directed deep into the ground towards our drinking water supply or directly to the Deschutes River without treatment.

Q. Can it go through the pavement?

A. Pavement is generally impervious and prevents water from soaking into the ground. Some specialty pervious pavements allow water to drain into the soil below.

Q. Can it collect in the grass or landscaping beds? Why or why not?

A. The landscaping beds in the parking lot are higher than the pavement and the parking lot does not slope towards them. Since water flows from high points to low points, the parking lot runoff cannot reach the grass or landscaping beds here. However, the water does travel through pipes to a detention pond for treatment, which is another example of low impact development.

#2 Old Mill Wet Pond Near the Deschutes River

Q. From where does this pond receive its water?

A. An inlet pipe that receives runoff from catch basins in the parking lots, and the nearby roadways.

Q. How has this pond also been designed to be an amenity to the development?

A. The stormwater detention pond doubles as part of a fly fishing casting course.

#3 Walkway Swale Along Riverside Homes

Q. How can concave landscaping like this swale act as both a stormwater filter and a privacy screen?

A. Concave shaped planting beds will capture the water and allow it to soak into the ground. The soil biota and plants help filter out pollutants. The plant height can also provide a natural privacy block.

Q. What benefits might the vegetated swale provide prior to runoff from the home sites reaching the river?

A. Vegetated swales collect and infiltrate stormwater back into the ground slowly. This helps to reduce peak river flows during rain fall events and provides treatment for the water through natural processes in the soil. The vegetation also helps slow the flow and remove some of the erosive impact of the force of the raindrops, which reduces soil erosion.

Q. How can soil (especially during construction), pesticides, and fertilizers from developed sites get into our waterways?

A. Pollutants can be carried by rain water or snow melt, irrigation overspray, wind, or manmade activities (e.g., sweeping) into gutters or directly to a waterbody. Excess material that washes into gutters or directly flows into the waterbody can end up polluting the river or ground water supplies.

Q. **What are ways to prevent that?**

A. Use erosion and sediment control Best Management Practices (BMPs) to keep soil from moving and leaving the site. Follow the pesticide or fertilizer manufacturer's directions. Only mix as much chemical as you need for one application, and dispose of excess chemical as hazardous waste (i.e. household hazardous waste should be taken to Knott Landfill or disposal). Do not apply material on windy days or when it is forecasted to rain.

Q. **Look across the river at the dog park. What pet care steps can be taken to help prevent water pollution?**

A. Scoop the poop and dispose of the waste in a trash can.

#4 Farewell Bend Park–Detention Basins

Q. **Where does the water in the detention basins come from?**

A. From the parking lots and Reed Market Road. Some park irrigation water may also enter the detention basins.

Q. **Where does it go?**

A. Small rain events soak into the ground at the detention basin while larger events will overflow into the river.

Q. **How do the plants help?**

A. Plants roots hold the soil in place and prevent soil erosion. Plants also remove pollutants such as heavy metals and oils.

#5 Farewell Bend Park–Habitat Protection and Restoration

Q. **a) Consider the vegetation behind the Habitat Restoration Area fences. Can this serve to filter water before it reaches the river? b) What other benefits does the vegetation provide to the river?**

A. a) Yes. b) The roots help stabilize the river banks and prevent erosion. Taller vegetation can help shade and cool the water.

Q. **a) The higher temperatures of the river are a "pollutant of concern." What might cause the temperatures in the river to be higher? b) How might the vegetation help?**

A. a) The direct sunlight warms ups slow moving water and shallow water tends to become warmer than deeper water. b) Plants and trees along the river provide shade and help keep the water temperature colder. The colder water is better for fish and some other species.

Q. **a) Can you see any trash from the bridge? How do you think it got there? b) What are steps that you can take to keep trash where it belongs?**

A. a) Trash left on ground or overflowing trash cans and debris in the road can be flushed into the river by a stormwater system or blown there by the wind. b) Place trash in garbage cans, preferably a trash can with a lid to prevent the wind from blowing the trash into the roadways or river.

Q. **a) Read the "Founding of Bend" sign. How was this stretch of river used during the logging days? b) How would the water quality of the river be different then and now?**

A. a) The River was used to store and transport logs and power the saw mill. b) It was continually dredged to remove sediment. The riparian areas were disturbed.

Q. **Examine the beach areas. Did you know that sediment and turbidity are also "pollutants of concern" for the river through Bend?**

A. Although all rivers carry some sediment, higher levels of erosion are found in developed areas, and especially during development or redevelopment activities. Sediment can cover spawning areas and affect other water quality factors in the river, such as reducing the clarity of the water.

Q. **Consider the green grass compared to the buffer areas. What can you do to help prevent nitrogen from reaching the river?**

A. The river is nitrogen-limited so excess nitrogen can result in excessive plant growth that could become problematic. Nitrogen is a common ingredient in fertilizers. Do not overwater. Minimize the use of pesticide and fertilizers, do not apply on windy days or right before a rain event; sweep up excess and dispose of properly. Minimize feeding of geese and ducks. If you have property along a stream or river, consider leaving a natural riparian buffer to protect water quality.

#6 Park Signs

Q. **a) In addition to the buffer area signage, have you noticed the "Please do not feed the geese and ducks" and Dog E Rest Stop stations? What benefits do taking these steps have to protecting the river water quality? b) How would the animal poop reach the river?**

A. a) All animals poop and poop contains high levels of bacteria and nutrients that can harm river water quality if not properly managed. b) Rain water runoff can flush the poop into the river.

#7 Reed Market Stormwater Median

Q. **a) From the Farewell Bend pagoda near the bathrooms, look out across Reed Market Road. Notice the shape of the landscaping between the two roads. b) Are most medians that you see like this one?**

A. a) Concave like a bathtub. b) No.

Q. **a) How is it different? b) How might its shape benefit stormwater?**

A. a) Most center medians are either made with impervious materials or they are mounded with dirt and the water runs off onto the street. b) A concave shape collects rain water and allows the water to soak into the ground.

Q. **a) Check out the trees in the median–do you think they take up much rainwater? b) Would a raindrop that hits a tree or vegetation first come down with as much force as if it just hit bare soil directly? c) How might this affect erosion of the soil?**

A. a) Yes, especially when they have leaves. b) No. The plants would absorb some of the force. c) It will help prevent erosion by decreasing the erosive force of the rain drop.

#8 Cliffs

Q. **a) Check out the cliffs–what are they made of mostly? b) Can water easily drain through the rock?**

A. a) This is the Tumalo Tuff which, along with the underlying Bend Pumice, was erupted in a single event from a volcano 10-20 km west of Bend. This Tumalo Tuff/Bend Pumice unit reaches thicknesses of up to 80 feet in Bend. This is one of three major tuff units in Bend, the others include Shevlin Park Tuff, and Desert Spring Tuff. (Note: Thank you to GSI Water Solutions for this information.) b) No.

Q. **How might that affect where stormwater goes?**

A. If the rock is not fractured the water cannot drain into the ground.

Q. **How might that affect treatment options?**

A. This could limit the use of swales or other stormwater disposal facilities that require infiltration or injection without fracturing the rock.

#9 Trees

Q. **Check out the trees along the road. Are their leaves out? How far out do they reach?**

A. Depends on the time of year, the height and type of the tree.

Q. **How do trees help protect stormwater quality?**

A. Trees leaves capture and hold water and lessen the erosive force of the rain drop.

Q. **If it is raining, notice if there is more or less rainwater hitting the ground under the tree canopy. What other benefits do they have?**

A. They provide shade and help keep the air temperatures cooler and water temperatures cooler when adjacent to a waterbody.

#10 Millpoint Center

Q. **Where are the cars parked?**

A. Under the building.

Q. **If each floor layer was taken off and set down on land so that the whole place was one story, including the parking, how much land would that take up?**

A. Roughly 3 times the size of all impervious area of the current building.

Q. **How does "reducing the building footprint" and the "parking footprint" help protect stormwater quality?**

A. It reduces the amount of impervious surface and decreases stormwater runoff volume and velocity.

#11 Bend Park and Recreation Administration Building

Q. **As you walk down the hill, notice the rooftop on the Bend Park and Recreation Administration Building. What is on the front section?**

A. The roof has plants growing on it. This is called an extensive green roof. Extensive green roofs are lighter weight (about the same as a tile roof) but are not meant to be walked upon. Bend also has an intensive green roof nearby at 360 Bond Street that also serves as a patio area (see page 22 of the guide for more details).

Q. **How might a green roof affect stormwater runoff and quality?**

A. The plants and roof detain the rain water and reduce runoff from the roof.

Q. **What other spaces may be a good candidate for a green roof?**

A. The adjacent restroom building near the large grass area.

Q. **Notice as you walk down the sidewalk, the concave landscape area bordering Columbia St. and Riverbend Park. Where does water come into this bio-retention swale (or rain garden)?**

A. a) From the street through a pipe hidden with rocks.

#12 Bend Park and Recreation District Administration Building Parking Lot

Q. **a) As you walk along the driveway of the Administration building, notice the median? b) How have they adjusted the curb and roadway to allow stormwater runoff into the median?**

A. a) Its concave shaped, designed to slow down and retain water runoff. b) The road slopes toward the curb; the curb has cuts that allow water to flow into the planting bed.

Q. **a) How does water move from around the building, and from one drainage swale across a road or sidewalk to another? b) What would you need to consider as you design these? c) Would certain sizes of trenches help reduce maintenance? d) Is access for cleaning important?**

A. a) Bio-retention swales and trench drains. b) Bark chips plugging the system, slopes, preventing erosion at outlets, aesthetics and operational needs. c) Larger sizes tend to work better to prevent clogging. d) Yes, very important for proper operation and to prevent localized flooding.

Q. **Could any of these features work at your home or business?**

A. Perhaps.

#13 Bend Park and Recreation Administration Building Pervious Asphalt Walkway

Q. **If you continue through the parking lot towards the dog park, you'll notice a walkway (and maintenance vehicle access drive) heading towards the river on the north east portion of the site. How does this asphalt look different from regular asphalt?**

A. Not as smooth as there are some void spaces.

Q. **a) If you have some water with you, pour some on. Where does it go? b) What benefits might this have for rainwater runoff or snow melt?**

A. a) Into the pavement. This is a pervious asphalt walkway. b) Less runoff and ice buildup. In addition, interactions within the asphalt pores help break down pollutants such as petroleum hydrocarbons, zinc, and total suspended solids.

#14 Les Schwab Amphitheater

Q. **a) What happens to rain and snow that falls on the Les Schwab Amphitheater? b) What if the amphitheater had been designed like a stadium with permanent seating–where would the rain and snow go then?**

A. a) It tends to soak into the ground given that the seating area is grass. b) Into a storm drain system and then likely directly to the river.

Q. **a) How can water conservation help protect water quality? If too much landscape irrigation water is applied, where does it go? b) Could excess irrigation runoff pick up pollutants such as oversprayed fertilizers on the way to the storm drain system?**

A. a) If too much landscape irrigation water is applied, it tends to run off into the stormwater system as a dry weather flow. In this manner it can pick up pollutants and carry them in the stormwater to the river or into the ground towards our drinking water. Using water conservation techniques such as smart controllers or cycle-and-soak settings and ensuring that irrigation lines and heads are set to minimize overspray can help reduce dry weather flows. b) Yes.

Q. **How can scientific data be used to help prevent runoff and misapplication of pesticides and fertilizers?**

A. Weather forecast can help especially when used with a smart irrigation controller; do not apply pesticides and fertilizers if rain or high winds are forecast.

Q. **As you continue along, notice the riparian buffer to your right? Notice any wildlife?**

A. Healthy riparian areas support wildlife and river health.

#15 Old Mill Quarter Wet Pond

Q. **How is a wet pond different from a detention basin?**

A. A wet pond is intended to remain wet throughout the year and retain or keep the water. A detention pond is intended to detain the water…allow it to slow down and settle out pollutants, and oftentimes infiltrate a bit before continuing to a final destination, such as the river. Detention basins can dry out in between storms.

#16 Old Mill Quarter Roadside Swale

Q. **Is it easier to see when maintenance is needed when a facility is underground or above ground?**

A. Above ground.

Q. **Does the swale provide an aesthetic buffer between the street and the uphill homes?**

A. Yes, swales with the correct plant material can make excellent buffers and be visually pleasing while helping to handle and treat stormwater. This longitudinal swale benefits from the absence of driveways together with easy accessibility along the roadway for maintenance.

#17 Residential Home Rain Garden/Pond

Q. **Are there areas of your yard that could use the extra water a rain garden would provide?**

A. Perhaps.

Q. **In areas away from the river, how might a rain garden look different? (hint, see picture on page 24 of the guide)**

A. In Bend, it may appear as a dry creek bed, or aesthetically lush area. The City has a list of plants suitable for Central Oregon rain gardens and guidance on how to create a rain garden for residential properties (see the link to “Additional Site Design and Low Impact Development Information” on page 24 of the guide). The area here stays wet more than most rain gardens would in Central Oregon. The plants for rain gardens need to be able to withstand inundation as well as drought conditions.

#18 Full Lot Coverage Storage

Q. **How does the property handle storm drainage when the structure abuts the downhill slope property line?**

A. Gutters and piped systems to underground storage facilities, released at a natural rate per Oregon Drainage Law requirements.

Q. **Is the underground storage used here similar to the use of rain barrels or cisterns on smaller properties?**

A. Yes, but on a much larger scale. Rain barrels are typically more visible, located on the side of the house rather than under the property.

Q. **As you walk along the Old Mill District back to the tour start, how is street runoff handled?**

A. Catch basins and trench drains in the middle of the street are piped to treatment detention ponds.

Q. **According to Oregon Drainage Law, adjoining landowners are entitled to have the normal course and amount of natural drainage maintained. How can you use the ideas seen today to meet that on your site?**

A. Work with the natural site topography and use concave landscape features to retain water. It helps to consider drainage at the very start of your project and take steps to reduce impervious surface area, especially directly-connected impervious surface areas. These techniques will allow you to both minimize the amount of additional runoff, and to handle it at the source where it is created. Source controls to protect against stormwater from coming into ontact with potential pollutant areas (for example, covering loading docks, trash bins, fueling areas) can also be very useful to prevent water pollution.

#19 Cascade Range: Look up to the Mountains

Q. **Most of the City gets its drinking water from groundwater aquifers (private purveyors within the City limits use 100% groundwater as their source; half of the City of Bend's water comes from surface water from Bridge Creek near Tumalo Falls). Where does the groundwater recharge come from?**

A. Over 60% of the recharge comes from snow melt from the Cascade Mountains, and 35% comes from canal leakage. Less than 2% comes from public and private underground injection controls (such as dry wells and drill holes). (Source: Pollutant Fate and Transport Model Technical Memorandum, GSI, 2011).

Q. **Can the steps taken to protect the river also be used to protect our groundwater drinking supplies?**

A. Yes.

Questions or Comments?

Please contact Wendy Edde, Stormwater Program Manager at 541-317-3000 or wedde@bendoregon.gov.

Accommodation Information for People with Disabilities

To obtain this information in an alternate format such as Braille, large print, electronic format and audio cassette tape please contact Karin Morris at (541) 693-2141 or email Kmorris@bendoregon.gov.