Roof Drains

Orem City Code 23-4-8(7). “All drainage from rooftop and dumpster areas are required to drain to vegetated landscape areas unless otherwise approved by the City Engineer.”

There are 3 Sections of this Document: Education, Implementation, and Notes on the Design

Education

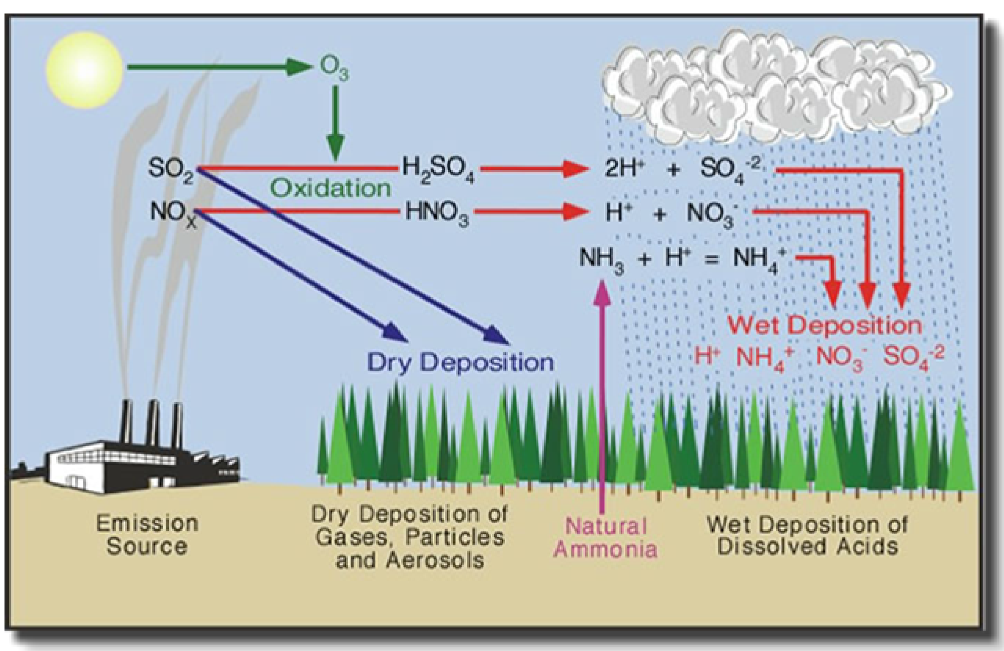
Roofs represent nearly half of the impervious surface here in Orem. Accordingly, great care should be taken to mitigate pollutants in roof run-off before it enters our storm water systems or infiltrates into the soil.

How does a roof produce contaminants?

Sources of roof run-off contamination are material leaching from roof structures and atmospheric deposition.

Leaching is the slow release of material components of the roof which is caused by the innate breakdown of the roofing overtime. This is caused by the elements (sun, wind, water) as well as chemical interactions which lead us into atmospheric deposition.

Atmospheric deposition is the deposit of chemicals onto the roof’s surface directly from the air. Chemicals settle out of the air and come to rest on the nearest surface of the earth (often roofs). Sometimes those chemicals just sit there until the next rain storm, other times they interact with the roofing material and increase its rate of breakdown. Rain drops can also attract particles out of the air and then deposit those chemicals onto surfaces during a rain event. That’s why Utah’s air looks so clean and fresh after a heavy rain!



Common contaminants found in roof run-off:

Key:

Na= Sodium	Cu=Copper	
Ca= Calcium	Zn= Zinc	Al= Aluminum
K= Potassium	Fe= Iron	Pb= Lead
Mg= Magnesium	Ni= Nickel	Si= Silicon
Ba=Barium	Cd= Cadmium	As=Arsenic

Types of pollutants:

Pesticides that were banned decades ago are still found in the environment (hence the banning), with concentrations from roof run-off exceeding drinking water quality standards (DWQS) set by the Department of Water Quality (DWQ).

Organic Pollutants are also found in roof run-off and are of concern "due to their widespread use, persistent character, high aquatic toxicity and endocrine disrupting characteristics". Meaning these pollutants can affect the nervous and immune system of both aquatic life and mammals (humans are mammals!). Though the majority of the organic pollutant load in storm water can be attributed to street runoff. (De Buyck, 2021)

Inorganic pollutants include heavy metals, metalloids, non-metals, nutrients, pesticides, and major mineral elements. These often come from roofing construction materials themselves. Si, Pb, Zn, Cu, Fe, and Al are found in highest concentrations. Zn, Cu, and Fe are harmful to aquatic life in the average levels found in roof run-off samples.

Why should we pay special attention to roof water?

So just how much does roof run-off contribute to overall storm water pollutant loads? Is it really worse than the pollutants that get washed off the cement and asphalt?
"Roof runoff was identified as the main source of Zn, Pb, Cd and Cu in urban wet weather flows in a combined sewer. 70% of Zn loads and 94% of the Pb loads in stormwater were attributed to roof runoff due to the used roofing materials." (De Buyck, 2021)
Fe and Al are naturally occurring in most wash waters since they are crustal elements so the high concentration in roof run-off waters is not surprising. The other common pollutants though can easily be attributed to our urban environment. Combustion of fossil fuels, emissions from industrial plants like cement industry, and even traffic congestion all contribute to metal

deposition. Orem is packed with some of these sources of pollutants and thus storm water quality is of particular concern for our area.

When comparing roof run-off to drinking water quality standards (DWQS), it is unusable for this purpose. The pollutants exceeding those standards also indirectly contribute to eutrophication and oxygen depletion of the receiving water bodies.

Common roofing materials used in Orem:

Metallic Roof Tops*
Wood shingles*
Asphalt Roofing (standard residential shingles)
Synthetic roofing (single ply)
Roof Tiles

*Most toxic roofing materials are treated wood and metallic roof tops.

Metal Roofs
The most common metal roofing materials are steel, copper, zinc, and aluminum. Metal corrosion can be a significant source of material leachate when it is washed off by a rain event. To prevent corrosion, metal roofing materials are often coated in a Zn-Al product. Unfortunately, the coating itself can also act as a contaminant source. An organic based coating also poses risks. Metal roofs create storm water runoff with high amounts of inorganic pollutants and some pesticides.

Wood Shingles
Wood is a naturally occurring product and seems eco friendly. However, to protect the wood from rapid degradation, increase fire resistance, and make it pest resistant, the wood shingles are very often treated with chemicals. Copper, zinc, and arsenic based components are used and found in high concentration in roof run-off. Even with untreated wood, the higher pollutants in that run-off is then nitrate, phosphate, and sulfate that fluctuates with the splitting of shingles over time due to weathering.

Asphalt Roofing
As you can imagine, asphalt shingles are made of many different materials such as distilled crude oil, polymers, APP (UV resistance), and a mineral top layer like sand or gravel. Although roof run-off pollutant concentrations are lower than with metal or wood product roofs, it still contributes negatively to overall storm water quality. Inorganic pollutants are found such as

nutrients and trace metals. Ni, Zn, Pb and Cu can be found in concentrations exceeding DWQS. Cu often comes from the granules added into the bitumen mix to inhibit the growth of algae, lichens and mosses.

Synthetic Roofing

Synthetic roofing is used for waterproofing purposes and is composed of a variety of polymers. They come as flexible sheets or can be applied as a liquid directly to the roof. This style of roofing is most often used for large retail buildings and commercial structures. Pollutants found in roof run-off from synthetic roofs include inorganic substances, organic contaminants, and nutrients. Zn, As, Ba and harmful inorganic compounds used as plasticizers can also be found.

Roof Tiles

These are typically only used for waterproofing steep roofs and are composed of ceramics, concrete, and natural slate. High concentrations of Si, Ca, K, Al, Mg, Na and Fe can be found in the roof run-off and “can be traced back to the mineral composition of the materials” (De Buyck, 2021).

Implementation

How can roof run-off pollutants be reduced or removed?

First, address the source. Construct roofs with the least polluting materials available for the project. Use proper sealants/barriers suggested by the manufacturer to best preserve the roof's integrity. Ensure the roof building process as well as chemical application methods are completed in ways that will best mitigate potential pollutants. For example, cleaning up the work site daily, storing chemicals properly, and timing certain construction phases with the weather for this area.

Second, mitigate the pollutants present in roof run-off using LID and/or BMPs. The City of Orem has several options for designers/developers in how to mitigate pollutants in roof run-off. This mitigation should occur BEFORE roof run-off enters any waters of the State. This includes before entering the main storm water infrastructure of any given site, the City's storm water system, or injection into the ground.

Vegetated Landscaping

Vegetation is the catch all when it comes to mitigating pollutants in storm water. There are many options in how to utilize plants such as bioswales, bioretention cells, green roofs, vegetated strips, etc. Many of these options are described in a document the DEQ published called *A Guide to Low Impact Development within Utah*. This document describes the calculations, effectiveness, and selection process for various LID. The publication can be found online here.

Plants are highly effective at storm water mitigation. The more dense of a root system the selected vegetation has, the better. This is due to the fact that many pollutants are attached to water molecules and roots uptake this polluted water. Some pollutants are also held to the roots by soil particles where they remain and slowly break down over time. Additionally, roots increase infiltration rates greatly, allowing for better storm water drainage into surrounding soils.
For these reasons, turf grass is an excellent option for pollutant removal with its robust root system. Turf grass can be water-wise, consult with a specialist on selection of turf that is drought tolerant or a native grasses mix.

Alternatively, rock beds and drought tolerant plants are also acceptable means of pollutant mitigation. Select plant varieties that have good uptake of (and high tolerance for) the predicted storm water pollutants of the proposed site. Plan the placement of plants in accordance with the design flow path of storm water. For example, plants used in the bottom of a retention basin should be tolerant of occasional standing water.

Wherever possible, use native plant varieties as these are often hardy, low maintenance, drought tolerant, and will thrive in this area. Recommended plant varieties specific to Utah and their uses with BMPs can be found in Appendix D and E of *A Guide to Low Impact Development within Utah*. The City of Orem Code also has an approved plant variety list. Even further, Canada has lists of plants that are good at phytoremediation and you can sort the plants by the expected pollutant your site will have that you intend to mitigate. The two databases are called Phytorem (phytoremediation) and PhytoPet (phytoremediation of petroleum).

Infeasibility

The City may accept alternative roof run-off pollutant mitigation for redevelopments that have existing 100% impervious surfaces, extremely poor infiltration rates, or it is determined to be infeasible to have vegetation (example: due to no existing or access to landscape irrigation system). Any roof run-off pollutant mitigation other than utilizing vegetation in an LID practice must be approved by the development review committee (DRC process). Some acceptable alternatives are as follows:

Alternative 1:

Engineered Soils

As previously stated, soil particles themselves can help retain pollutants and increase the rate at which they break down. An engineered soil is one that is designed with specific amounts of clay, silt, sand, organic matter, and other specific additives in order to create the ideal environment for water storage, infiltration rates, and pollutant mitigation.

For example, “the Alabama Department of Environmental Management (ALDEM) recommends a standard bioretention media mix based on the state’s precipitation characteristics. The mix contains about 85% sand, 11% fine grains of silt and clay, and 4% organic matter, such as hardwood mulch. Numerous applications have demonstrated that this mixture excels at stripping heavy metals, such as zinc and copper, from runoff and can reduce phosphorus concentrations by as much as 95% or more.” (Jacques)

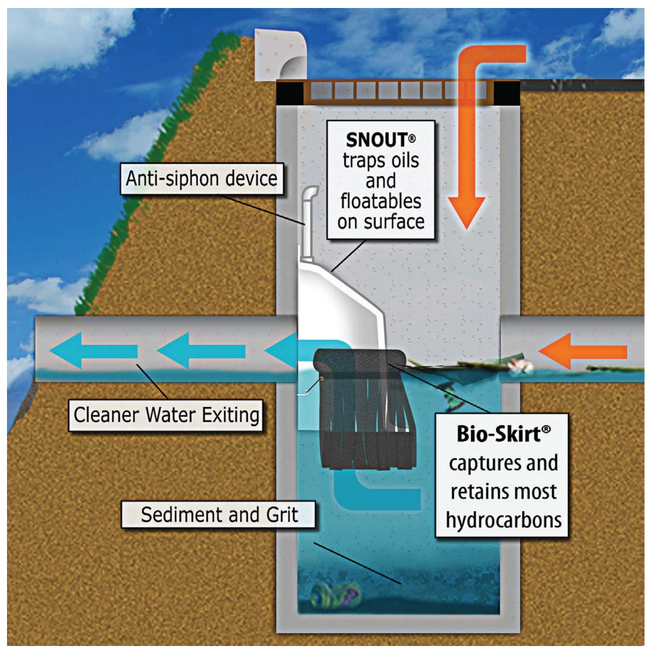
Some soil additives are costly, but can be a good option to meet pollutant mitigation objectives when vegetation is not an option. One particularly effective engineered soil additive are zeolites. Zeolites are a soil amendment featuring forms of aluminum and silicon. They excel at retaining nitrates which is not typical for soils without vegetation. When using an engineered soil, consider additives that target pollutants specific to the site.

Alternative 2:

Filter Media/Proprietary Devices

There are many options for different types of filters that are highly effective at removing pollutants such as metals and nutrients. Filters can even be engineered to remove specific target pollutants for a given site. One reason filters are not more commonly used is the nature of how they function best in a multi-stage process. For example, large soil particles will plug up the filter so it's essential to allow larger particles to settle out of storm water before the water passes through the filter that captures tiny pollutant particles. A second reason is the maintenance burden. All filters require regular replacement or maintenance at the manufacturer's recommended interval. Depending on the device and the rainfall in the area, this scheduled maintenance could fluctuate significantly causing potential system failure.

Proprietary devices such as a snout are effective at treating storm water and are the most commonly used form of pretreatment in Orem. Snouts provide sedimentation (the settling of larger particles to the bottom of the basin) and floatable pollutants (trash, oils, etc) stay on the surface of the water in the basin. Then, only cleaner storm water can enter the snout and be conveyed into the storm water system or other device such as an injection well ie. sump. There are many proprietary devices available and it is encouraged to use one that will best mitigate the target pollutants for the given site.



Option 3:

Other

Any design approved by the City Engineer or DRC that will accomplish the same or better pollutant mitigation as vegetation LID or Alternatives 1 and 2.

Notes on the Design

Building Code:

Design roof water run-off devices in a way that will be able to appease both storm water treatment goals and building code requirements. **Building code requires that the grade surrounding the foundation of a building slopes away at 0.25”/foot for 10 feet**. This protects the building foundation from water damage. So if roof water is intended to discharge near the base of the building (as many downspouts do) ensure that slope requirement is met.

For buildings with a basement, do not discharge the roof run-off any closer than 5 feet away from the base of the building. This will reduce chances of water damage to the foundational walls as water can move laterally and downward when it percolates through the soil.

Basin Storage Capacity:

Another item to consider is how much area is needed in a roof water outfall zone. Ensure an engineer calculates the volume of water that will discharge from the roof during a 25 year storm event and size the area receiving that run-off accordingly.

In the design, also account for where overflow storm water will go in the event of a larger storm. Show the 100 year storm overflow path in the proposed grading and drainage sheets submitted to the City.

How much vegetation?

In a swale, retention basin, etc. where vegetation is used to help mitigate pollutants from roof run-off, about 50% of the lowest part of the area should be evenly vegetated.

City Planning Requirements:

For sites with frontage property, 50% of the area of the front setback must be vegetated. It is often beneficial to pipe roof run-off to these areas where possible since vegetation is already required in that area.

In summary, in achieving storm water goals, ensure that you are also in line with other City requirements.

If there are specific questions please contact:

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