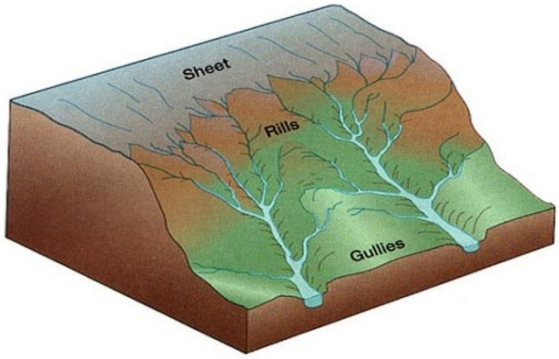
Hydrological Effects of Destination Resorts

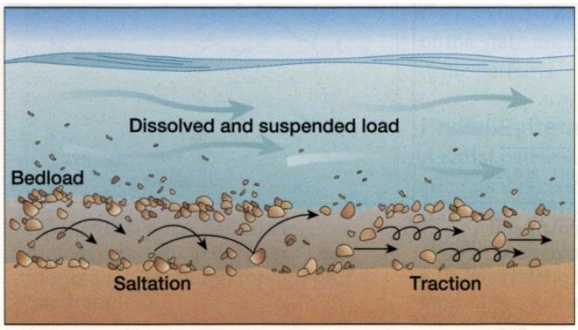
Tom Davis, PE, November 15, 2013

The four primary stream impacts of destination resorts in the Whychus watershed are erosion-sedimentation, flow, water temperature and eutrophication. Stormwater runoff will be a problem but can be mitigated.

Erosion - Sedimentation

The most threatening hydrological impact of destination resort development on streams and fish habitat is the serious impairment of spawning gravel by sediment delivery from eroded soils.





The filling of gravel interstices with fine to coarse sediment causes major salmonid reproduction problems. Eggs and alevins must develop for two to eight months in gravel redds, depending on the species, and require sufficient flow of well-oxygenated water during the entire period. A majority of the aquatic macroinvertebrates that provide forage for fish are produced within clean, silt-free gravel, cobble, and boulder substrates and can be severely impacted by sedimentation. The science is clear but widely ignored.

Erosion occurs at development sites due to exposed soils, particularly from construction equipment. The phenomenon has been well documented by numerous research projects over at least four decades, but because surface/sheet erosion is difficult to observe it is often regulated insufficiently. Suspended sediment is addressed through water quality standards but bedload sediment, which is dominant in the Whychus watershed, requires complex monitoring and is seldom regulated.

Mass (landslides) and channel erosion, can also occur, but are more easily observed than surface/sheet erosion so effective regulatory constraints and mitigation measures are applied more consistently.

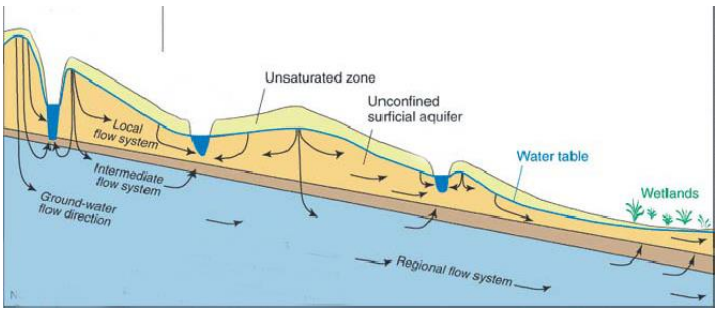
Flow

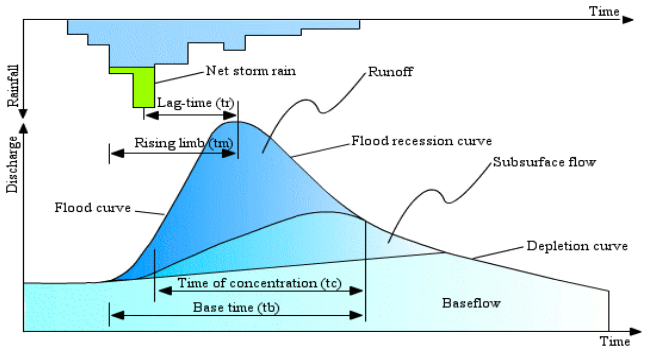
Stream flows depend on groundwater and can be reduced by the lowering of groundwater due to wells at destination resorts. This can create serious, detrimental impacts on aquatic life during the critical low flow periods. Sometimes this groundwater inflow to streams or lakes occurs from springs like those at Alder Springs and Camp Polk, but usually it's from inflow along all or most of the length of the stream. The impacts are often ignored by regulators since it's hard to document after the fact for court purposes, and very expensive to predict. The groundwater in the Upper Deschutes is essentially one system. But regardless of how we simplify or visualize the system there are thousands of variables and exceptions. However one thing is clear, groundwater withdrawals adversely affect both flow and temperature in nearby streams.

From a hydrograph analysis perspective there's base flow, which is usually from a more consistent and deeper groundwater flow system, such as the Upper Deschutes Basin aquifer. There's also subsurface flow (interflow), which is from shallower and more seasonal groundwater in the duff, soil or shallow-pervious

geologic formations. It usually kicks in during storm events as the saturated zone moves closer to the surface. There's also surface runoff, which is rare for the Deschutes west side subbasins except on frozen ground, but more common in the Crooked River subbasins.

It's a dynamic, 3-dimensional complexity that varies with time. The shallow, local groundwater movement closer to the surface for most systems can and often is different than the regional/deeper system(s), even if they're connected. This is particularly true near small streams such as Whychus Creek. It is, of course, a continuum, except where there are impermeable confining layers.





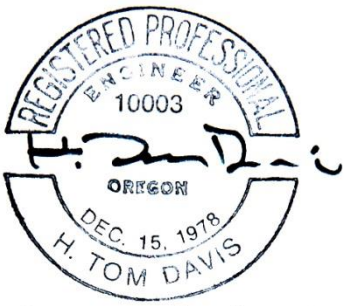
Water Temperatures

(Adapted from OSU Thesis - http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/20792/JonesLesleyM2011.pdf?sequence=1)
Although temperatures for steelhead trout are considered optimal (<65 °F) at the Sisters City Park at river mile 24.25, the current Whychus flow target of 33 cfs provides sub- optimal (65 – 70 °F) temperatures of 69 ± 3.8 °F downstream at USFS Road 6360 (river mile 6.0) for steelhead. To reduce instream temperatures and meet state temperature criteria for steelhead in Whychus Creek 67 cfs of flow is recommended during July. Groundwater entering the stream through springs and seepage is the most important source of cool water at the Whychus middle reach and below.

Eutrophication from Nutrient Enrichment

Another major, detrimental impact is the eutrophication of streams and lakes from nitrate originating at on site wastewater systems or fertilizers and transported via groundwater to surface waters. This has occurred at hundreds of locations nationally, but is even harder to observe than surface erosion. Nitrate can be routed through the groundwater-surfacewater system in months or decades so timing contributes to the difficulties of observation. Once nitrate reaches the surface water it can contribute to more algae and plant growth, which usually damages healthy aquatic ecosystems. The reasons include the decay process involving the removal of oxygen during decay, and organic deposits from the plant decay over spawning gravel.

Upper Deschutes streams are nitrogen-limited systems. This means that additional inputs of nitrogen, even in extremely low quantities, can cause algal blooms, excessive plant growth, oxygen depletion, changes in pH, and other important changes that are detrimental to aquatic ecosystems. The guideline for nitrates in drinking water is 10 mg/L. According to a *local* Whychus water quality specialist the relevant guideline for total nitrogen in Whychus is 0.12 mg/L. This illustrates the extreme sensitivity of freshwater ecosystems to nitrogen inputs. In the Upper Deschutes streams, such as Whychus Creek, even small inputs of nitrogen from septic systems or surface runoff can result in significant, detrimental impacts to the fisheries and aquatic ecosystems.



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