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Thermal pollution of trout streams from stormwater runoff

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Urban development dramatically alters a drainage system through landscaping, changes in surface cover (pavements and buildings), and addition of new storm sewers and detention ponds. Increased surface runoff due to impervious surfaces can lead to temperature increases in receiving streams and degradation of habitat for coldwater fish such as trout. To enable prediction of these thermal impacts due to land use changes, detailed hydro-thermal process models have been developed for surface temperatures, surface runoff, and heat transfer between the land surface and the runoff. These hydro-thermal models, along with measured climate and surface temperature data, have been used to characterize how different land uses and storm event characteristics control the amount of heat energy transferred from land surfaces to receiving streams. The end goal is to develop a robust simulation tool that can be used by state agencies within a permitting process to evaluate the thermal impact of new developments prior to construction.

Increased impervious surface area and, in particular, paved surface area, leads to increased potential for thermal impact via both increased quantity of runoff and increased temperature of runoff. Unmitigated runoff from a rainfall event with a high dew point temperature (rainfall temperature) can, in itself, produce temperature spikes in coldwater streams. Thus any impervious surface (including rooftops and pavement) or semi-pervious surface (such as lawns with compacted soils) has the potential to thermally impact nearby streams. Paved surfaces can cause additional heating of the runoff. The amount of additional heat added to the runoff depends on both the characteristics of the storm event and the prior climate conditions. For example, high solar radiation followed by the rapid onset of cloud-cover leads to relatively high pavement

temperature at the onset of rainfall and warmer runoff temperature. Therefore, detailed hydro-thermal runoff analysis requires climate data with high temporal resolution that includes measured solar radiation. Using a six year climate record with 15 minute resolution, return periods for storm events of varying thermal impact potential have been analyzed. Storms with high thermal impact include events with large quantities of rainfall at a high dew point temperature or moderate rainfall amounts combined with high land surface temperature. This information can be used to choose appropriate storms to evaluate thermal impacts of new development, with an understanding of how often thermal pollution is likely to occur.