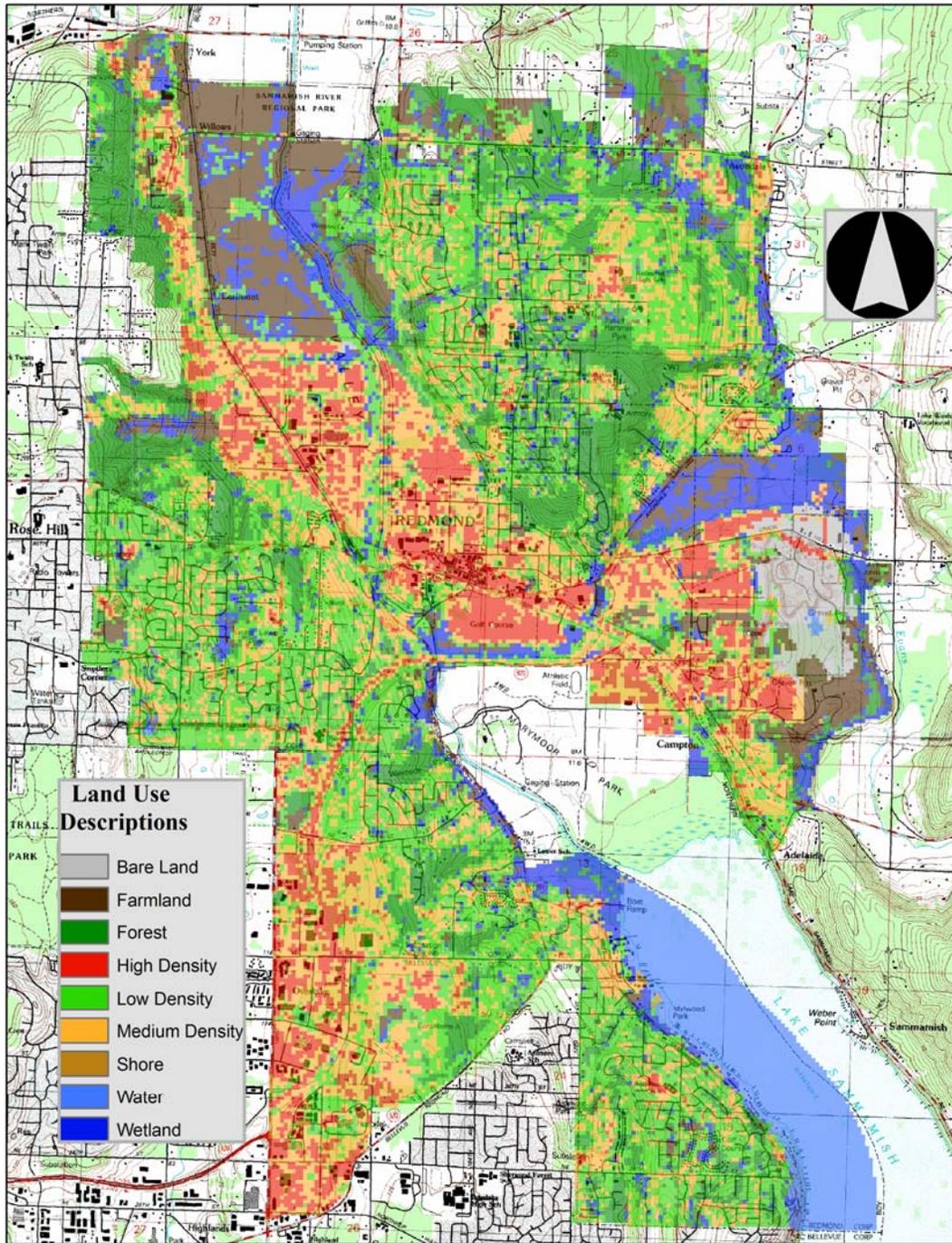


REDMOND URBAN WATERSHEDS INITIATIVE

EXECUTIVE SUMMARY



**A Collaborative Study
October 2008**



Generalized Land Use within the City of Redmond (2001).

Cover photos, clockwise from top left: Upper Idylwood Creek; North Redmond single family residential, TIS (red) of 40%; 85th Street stormwater outfall from Downtown Redmond; Old Downtown Redmond, TIS of 80%.

REDMOND URBAN WATERSHEDS INITIATIVE (RUWI)

EXECUTIVE SUMMARY

ABOUT RUWI

The Redmond Urban Watersheds Initiative (RUWI) is a collaborative effort of the Washington State Department of Ecology, United States Environmental Protection Agency, and the City of Redmond to explore ways to reduce stormwater-related impacts to the City's surface waters. For this project, the RUWI team examined the relationships between land use and pollutant generation associated with stormwater systems in Redmond. To do this, the RUWI team:

- Summarized the history of stormwater management in Redmond.
- Examined interrelationships among land-use, impervious surface, and surface water quality across Redmond watersheds.
- Examined the relationship between Bellevue, Washington's (an adjacent city) storm-event water quality data (1988-1993) and watershed impervious surface levels.
- Applied EPA's water quality duration curve methodology to Redmond's streamflow and surface water quality data.
- Explored relationships between several additional landscape-level, watershed land-use variables, and surface water quality.
- Modeled alternative futures for Redmond's land-use and related them to future surface water quality.

This report summarizes key findings from RUWI's analyses and offers a set of strategies (a roadmap) for Redmond to follow to address several current and anticipated water quality challenges related to stormwater pollution.

STUDY AREA BACKGROUND

The City of Redmond lies within the Puget Sound Lowlands, approximately 20 miles east of Seattle at the north end of Lake Sammamish. It is the seventh most populous city in King County (50,700 in 2007) and encompasses approximately 16.9 square miles. Incorporated in 1912, the City grew slowly through the mid-1960s. Growth accelerated rapidly in the 1970s and 1980s when it earned Redmond the reputation as one of Washington's fastest growing cities.

As Redmond developed, its forests and valleys were converted to impervious surfaces (roofs, roads, driveways). Precipitation (rainwater) that had previously soaked into the ground (infiltrated) or been intercepted or deflected by trees now moved swiftly over the hard surfaces, picking up pollutants on its way to nearby surface waters (creeks, rivers, and lakes). To better manage its stormwater, Redmond established a Stormwater Utility in 1988. The City also passed its first "Sensitive Areas Protections" in 1992 in response to the State's Growth Management Act (1990). The Stormwater Utility initially focused on water quantity – how to quickly move stormwater off the streets and away from buildings and to the Sammamish River or Bear Creek, Redmond's major waterways. Following the passage of the Washington Growth Management

Act, the Utility expanded its emphasis to address the chemistry and water quality of stormwater runoff, in addition to water quantity (flooding) and conveyance (stormwater infrastructure system) concerns.

Today, Redmond's Stormwater Management Plan includes at least 34 program elements that are supported by staff from several Divisions of Public Works, as well as the Planning and Parks Departments. The City recently adopted amended regulations to actively encourage Low Impact Development (LID; 2007) and expedited implementation of regional stormwater treatment facilities to "retrofit" highly urbanized watersheds in Redmond's downtown core and the Overlake neighborhood.

REDMOND'S CURRENT WATER QUALITY

In 2003, Redmond Natural Resources staff conducted a city-wide, comprehensive analysis of surface water quality data. These analyses confirmed violations of State surface water quality standards at several sampling locations across the city. High levels of fecal coliform bacteria were the most widespread problem, followed by low dissolved oxygen and high temperatures. Redmond also initiated a "First Flush" stormwater sampling program in 2003 to test for dissolved heavy metals, hydrocarbons, and a variety of organic chemicals in stormwater discharges. This monitoring program was repeated in August 2006. The 2003 first flush sampling analyses indicated high levels of dissolved heavy metals (copper, lead, and zinc) and PAHs (polycyclic aromatic hydrocarbons – carcinogenic pollutants commonly traced to fuel combustion). Birth control hormones, suggesting contamination of the stormwater system with sewage, and multiple endocrine disrupting compounds (EDCs) were also detected in some samples. Numerous 2006 samples also included excessive concentrations of copper, lead, and zinc. Other pollutants were recorded on a more sporadic basis, including pesticides (heptachlor and Beta-BHC) and other organic compounds related to vehicle exhaust, solvents, and plasticizers.

Beginning in 2001, biological data were also collected on an annual basis. These biological data exhibited a similar pattern to that noted from the physical and chemical data. Poorer water quality and stream health were recorded from the more heavily developed western portions of Redmond that drained to the Sammamish River, while the less intensively developed northern and eastern portions of the City, that drained to Bear Creek, demonstrated generally better water quality and stream health.

These water quality findings, although troubling, are not unique to Redmond. Surface water samples, including stormwater, collected in other parts of King County and around the Puget Sound Lowlands show similar pollutant types and concentrations.

RUWI STUDIES/FINDINGS

The RUWI analysis described in this report is built around five different studies that consider the relationships between land cover, impervious surface, and surface water quality.

- (1) The RUWI team first examined surface water quality data collected from 41 locations throughout Redmond (1995-2005) to generate a local Water Quality Index (WQI) that ranks the relative water quality among different watersheds (local drainage basins). Through a characterization of land-use types and total impervious surface (TIS) levels within each watershed, the analysis confirmed a significant ($p>95\%$) relationship ***that increasing impervious surface results in declining surface water quality***. The analysis also confirmed ***that the mix of land-use types within a given watershed can be used to predict the surface water quality conditions expected within that watershed***. A related finding was that current stormwater facilities and best management practices (BMPs) do not adequately protect Redmond's creeks and rivers from water quality pollution problems.
- (2) The RUWI team then tested local WQI scores for 18 Redmond watersheds against a range of landscape variables expected to affect water quality. The impervious surface/water quality relationship was reconfirmed and several additional hypotheses emerged:
 - ***Higher 10-year peak flow discharge rates are strongly correlated ($p>95\%$) with declining surface water quality.***
 - ***High and medium density development is strongly correlated ($p>95\%$) with declining surface water quality.***
 - ***Within a given watershed, increasing the ratio (as a percentage) of total length of stormwater pipes to the total length of open stream channels is correlated ($p>90\%$) with declining surface water quality.***
 - ***Increasing watershed total forest cover is positively correlated with better surface water quality. This relationship is even stronger for forest cover within stream buffers.***
- (3) Next, the RUWI team re-analyzed storm event data collected from Bellevue, an adjacent jurisdiction (1988-1993), to understand how impervious surface levels within a watershed affects water quality. This analysis concluded that (1) ***storm event runoff -- a primary factor in mobilizing pollutants -- increases sharply in watersheds with higher levels of impervious surface***; (2) ***stream base flows decline as impervious levels increase***; and (3) ***a majority of pollutants exhibit increasing concentrations and higher yields to receiving waters, as watershed TIS levels and related stormwater runoff increase.***
- (4) A fourth analysis applied "water quality duration curve" analyses to data collected in seven small Redmond watersheds and four nearby water quality stations monitored by King County. This analysis confirmed that ***as small urban watersheds are developed, their water quality tends to become increasingly impaired and increasingly extreme*** (i.e., higher highs and lower lows). Discernible patterns emerged for turbidity, fecal coliform bacteria, and conductivity, when plotted against changing stream flow conditions.
- (5) Lastly, the RUWI team modeled several future "build-out scenarios" for Redmond's watersheds to understand how development within and across watersheds is expected to modify TIS levels and, by extension, future surface water quality. A specific conclusion of this analysis was ***that more widespread land-use zones with lower current development levels offer the greatest opportunities for reducing the future growth of impervious surfaces***. For example, low/moderate density residential zoning alone, represents 42% of the potential future growth in impervious surfaces across the City.

An “alternative build-out” scenario indicated that if the City were to reduce future TIS levels within the low/moderate density residential zoning category by 50%, overall City-wide TIS levels at build-out would only be reduced by 7%. This finding yielded the final, and perhaps most sobering conclusion of the RUWI project: ***that traditional planning and building practices resulting in any increase in present levels of TIS across Redmond will inevitably result in more runoff, further declines in water quality, and possibly more water quality impairments and 303(d) listings.***

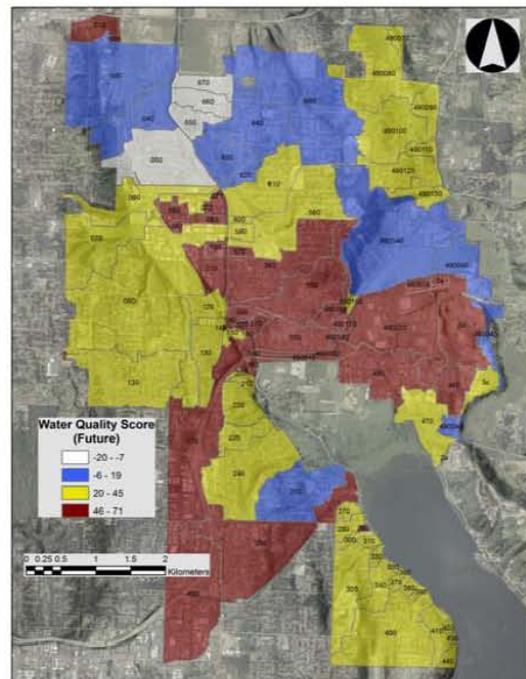
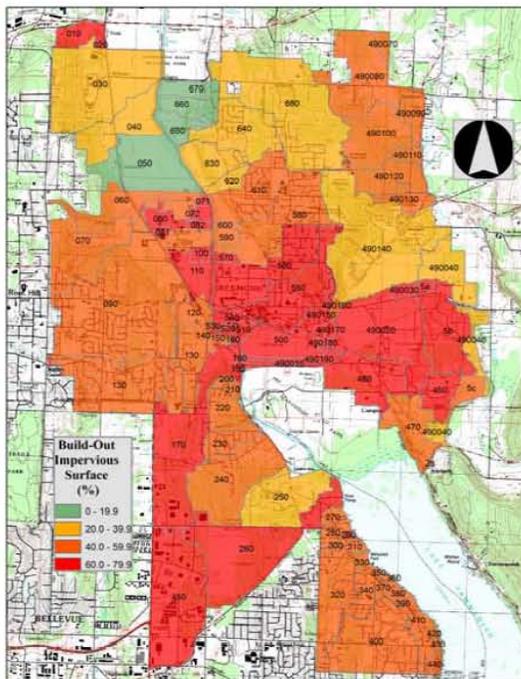
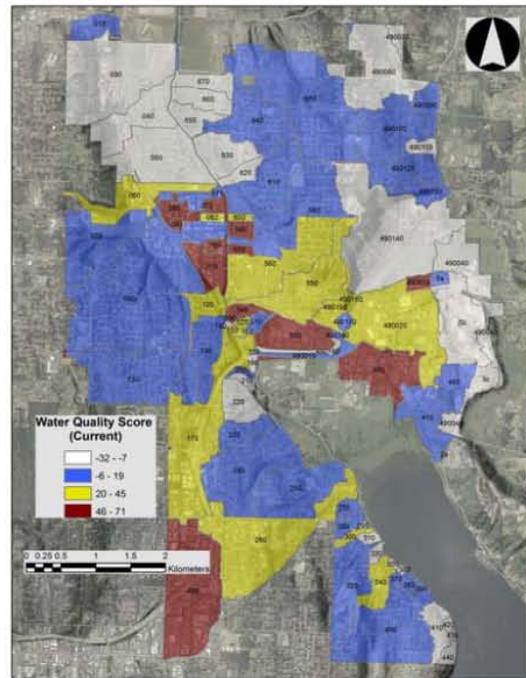
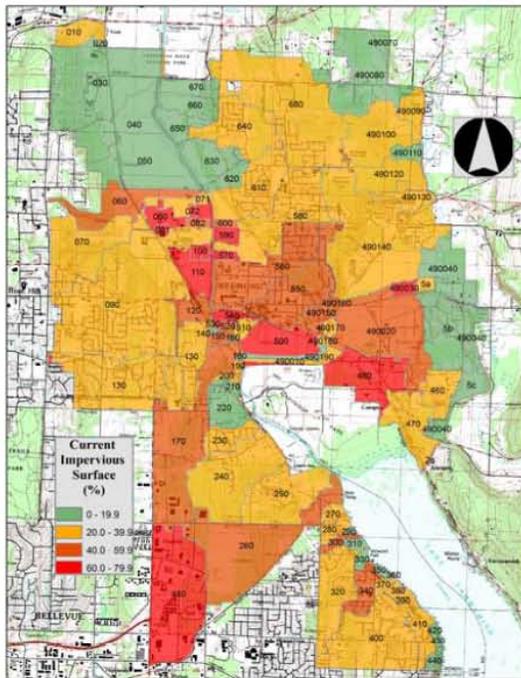
ROADMAP FOR REDMOND’S WATER QUALITY FUTURE

RUWI study findings provide powerful guidance for devising solutions to address Redmond’s present and pending surface water quality problems. The final section of the RUWI report synthesizes these approaches into a single, holistic framework that engages citizens, businesses, and government alike. The framework calls for the following key actions:

- (1) ***Incorporate a “watershed perspective” into the planning and work*** done by City government, residents, and businesses. Watersheds are the natural units within which land use, TIS, stormwater, and surface water quality issues all come together. Watershed-centered thinking drives effective planning and action across a range of disciplines.
- (2) ***Protect and enhance Redmond’s “Green Infrastructure,”*** including the North-South Sammamish River corridor and the still largely wooded side-walls of the Sammamish Valley; the North-South swath of City Park-lands that buffer rural King County; the East-West open-space corridors along lower Bear-Evans Creek; the Puget Power Trail (Willows Creek to Farrel-McWhirter Park); and all of Redmond’s natural lands and Native Growth Protection Areas. Encourage and support tree planting and soil enhancement on both public and private lands. Disconnect impervious surfaces and maximize stormwater retention and infiltration wherever possible.
- (3) ***Expand source control programs*** through street-sweeping, erosion control, application of BMPs in business parks and commercial areas, and other activities. Apply Low Impact Development (LID) stormwater management techniques to encourage stormwater infiltration. Establish and maintain bioswales and other natural systems to “cleanse” stormwater before it reaches creeks, streams, lakes, and aquifers.
- (4) ***Expand stormwater outreach and education*** to all segments of Redmond’s “public” so that they become informed stewards of the City’s diverse natural resources. Reach out to homeowners, students, landscaping businesses, and others who may not be aware of Redmond’s sensitive resources and who contribute pollutants unknowingly.
- (5) ***Minimize the creation of new effective impervious surfaces.*** Actively explore the value and impact of requiring full implementation of LID technologies in ***all*** future development and redevelopment projects across the City.

- (6) **Maximize stormwater infiltration where appropriate**, recognizing Redmond’s reliance on shallow aquifers for its drinking water. Continue efforts to develop reliable, effective regional and local stormwater infiltration facilities. Explore how LID and other approaches can support this effort across all land-use zones in the City.
- (7) **Install regional stormwater treatment facilities** to actively collect and treat polluted stormwater runoff, especially in parts of the City where development density provides stormwater collection and treatment efficiencies. Focus these **stormwater “retrofit” projects** in high density land-use areas to address existing stormwater quantity and quality concerns.
- (8) **Actively consider stormwater management opportunities and challenges during land planning and urban development processes.** To do so will require the City to fully consider stormwater management and surface water quality concerns during:
- Neighborhood planning efforts.
 - Public and private land-use planning, development and construction activities.
 - Modification and review of zoning and land-use regulations.
 - Consideration and promotion of LID methods across land-use types.
 - Development review, and construction approval processes.
- (9) **Continue to monitor changes in water quality, along with the effectiveness of individual and collections of stormwater management practices and land use decisions**, to allow the City to adaptively manage its activities, projects, and programs.

To find out more about the Redmond Urban Watershed Initiative
Contact the City of Redmond, Public Works Natural Resources Division, Mail Stop 2NPW,
P.O.Box 97010, Redmond WA 98073-9710, or call (425) 556 – 2701, or E-Mail us at
nr@redmond.gov



Total Impervious Surface by Watershed: 2001 (above) and at projected build-out.

Water Quality Score by Watershed: 2001 (above) and at projected build-out.