# Low Impact Development Analysis

Increasingly in the news, low impact development (LID) is becoming a standard stormwater management tool for development. Recently the United States Environmental Protection Agency (EPA) issued a memorandum strongly encouraging the use of green infrastructure approaches to managing stormwater runoff to the maximum extent possible. This follows on the heels of the Washington Department of Ecology's (DOE) release of draft LID permit language for inclusion in the next round of Western Washington Municipal Stormwater Permits. Simply stated, LID over the next few years will evolve to be more integrated into how development and redevelopment is built.

Also sometimes referred to as "green stormwater infrastructure", LID is formally defined by the Department of Ecology as,

> A stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed stormwater management practices that are integrated into a project design.

In practice this definition includes such structural best management practices (BMPs) as permeable pavements, green roofs, bioretention and rain gardens, as well as LID development principles like maximum impervious surface standards and native vegetation conservation requirements.

While LID is a complex topic with many facets, the focus of this paper is to provide an update on the current level of LID implementation in the City of Olympia, detail the successes and lessons learned from a representative selection of Olympia LID projects, and provide some context in regard to LID implementation by other cities in the region. Attachment 2 delves more deeply into specific potential code changes that better support and encourage LID in Olympia's public and private development projects.

## Status of LID in Olympia

### Structural Installations

The Olympia Public Works Department started installing LID techniques more than a decade ago. In 2007, City Council approved direction for the Department on the use of permeable pavements. One of the City's first projects and most commonly utilized installation since then has been pervious sidewalks. Currently, Olympia has more than 4 miles of pervious sidewalk throughout the City. Staff has developed a map to track and publicize the types and locations of LID installations throughout the City (Attachment 3). The map will continue to be updated and be posted on the City's website.

### Code Regulations

Over the last decade, the City's zoning code and development standards have been updated to increasingly incorporate low impact development-friendly regulations. In order to gauge Olympia's current code status, staff completed the Center for Watershed Protection's Code and Ordinance Worksheet. The worksheet compares our current development rules to model development principles.

Out of a total possible 100 points the city's codes scored 85 points (Attachment 4). While not perfect Olympia's codes are overall "pretty good", but could use tweaking in some areas. The worksheet helped identify code areas to consider changing. Areas for improvement included: cul-de-sac width, structured parking requirements, sidewalk width, alternative pathways, and driveway widths. Often there are trade-offs and competing objectives to discuss between transportation, stormwater and community planning and development. For instance, while transportation planning may favor larger cul-de-sacs to easily facilitate fire truck turnaround, stormwater planning may support smaller cul-de-sacs in order to reduce impervious surface (see Attachment 4 worksheet, question #4).

The Summer 2013 re-issuance of the Western Washington Phase II Municipal Stormwater Permit will include requirements to review and amend our local codes and standards to include LID best management practices (e.g., permeable pavement, bioretention, and vegetated roofs), as well as LID principles (e.g., maximum impervious surface limits or a percent of native vegetation to be retained). A companion document, Integrating LID into Local Codes: A Guidebook for Local Governments, meant to aid in this code amendment process has been recently released by the Puget Sound Partnership. Staff anticipates this guidebook to help guide the process for future regulation updates. The expected Phase II permit deadline for complete update of all necessary city codes, rules, and standards is December 31, 2016.

## Olympia Case Studies

### Decatur Street LID Demonstration Project

The Decatur Street LID demonstration project constructed and quantitatively compared three different stormwater management LID street designs on a two block section of Decatur Street SE between 9th and 11th Avenues SE in West Olympia. While the technologies implemented are not new, this project combined the elements in ways to meet the goals of flow control and treatment within the existing right-of-way.

The LID techniques used to retrofit the three different sections of the pavement (each approximately 210 linear feet) were:

a. Regular asphalt pavement overlying an under-pavement infiltration system with catch basin stormwater filtration units.
b. Porous asphalt pavement overlying an under-pavement infiltration system.
c. Regular asphalt pavement overlying an under-pavement infiltration system with a planter strip rain garden for stormwater treatment.

### Successes

- Water quality monitoring results confirmed that catch basin filter cartridge systems are effective for the removal of TSS, copper, phosphorus, total nitrogen, nitrates and hardness.
- Porous asphalt water quality monitoring results consistently showed removal of zinc.
- The Decatur Street project improved stormwater flow control and fulfilled the LID goal of managing and infiltrating rainfall as close to the source as possible.
- No pavement repairs have been required to date and no need for pavement rehabilitation is anticipated in the foreseeable future.
- Despite additional construction costs, the ability to manage stormwater within the right -of-way makes under-pavement infiltration systems attractive compared to purchasing high-value land for centralized stormwater facilities.

### Challenges and Lessons Learned

- The flow control design objective was not fully achieved. The under-pavement drainage layer was observed to be inundated on more than one occasion, verifying poor infiltration rates. This project demonstrates that shallow groundwater and poorly infiltrating soils inhibit the effectiveness of under-pavement infiltration systems.
- The constructed under-pavement infiltration design is not highly efficient. The design requires moving water underground against the natural slope of the roadway. This requires that a deeper than needed drainage layer be installed. This condition would only be made worse with steeper roadways. An improved design would infiltrate the runoff from one section of roadway under the pavement of the immediately down gradient section of roadway. In this way, water would only need to be moved down gradient.
- Under-pavement infiltration systems require deeper excavation and more material than do traditional roadway designs. The extra depth of the roadway system can conflict with utilities under the pavement. If the under-pavement infiltration systems are adopted as a standard, the depth of utilities should be increased and where possible located outside of the pavement section so that future utility repairs are not hindered.
- Some pavement raveling was observed in the porous asphalt parking strip; presumably due to wheel turning associated with parking.
- Future projects should be designed with sealed water quality monitoring ports to prevent surface water inflow.
- Compost used to amend rain garden facilities should be investigated to determine the leaching potential of water quality target constituents, particularly nitrogen.

## RW Johnson Boulevard

Constructed in 2006, the RW Johnson Boulevard project was the City's first project to install permeable bike lanes. In association with planned safety and mobility improvements on RW Johnson, between Black Lake Boulevard and the city limits with Tumwater, this project incorporated two pervious concrete bicycle lanes adjacent to two standard asphalt vehicle lanes. The bicycle lanes treat and infiltrate the stormwater runoff generated by the vehicle travel lanes. The roadway project also includes pervious concrete sidewalks along the length of the roadway. Additionally, the planter strip between the sidewalk and roadway is amended with compost to enhance its infiltration capability.

### Successes

- The pervious concrete bike lanes appeared to be successful for several years of operation. However, during the winter of 2010-2011, spalled joints were observed in portions of the bike lanes. Failure of the pervious concrete has been attributed to the PercoCrete concrete mix used in construction. The bike lane pavement will be replaced in 2012 or 2013 with other permeable pavement materials using the pavement "insurance fund".
- The project was comparatively low risk due to favorable soils for infiltration in the project area, as well as an adjacent stormwater facility (Black Lake Meadows) in the event of any failures.

### Challenges and Lessons Learned

- In general, pervious concrete is difficult to batch and correctly install in a timely manner. Placing pervious concrete in the project was preceded by several pre-pour meetings with the batch plant and applicator in addition to a series of test panels of the pervious concrete material. PercoCrete pervious concrete proved to be more difficult to install than regular pervious concrete.

- Even with the best care and quality control at the time of concrete placement, we experienced some structural failures. Some sections failed due to lack of strength, others failed to infiltrate. The failures could be tied to individual truck loads of concrete. This link suggests that faulty batching is the dominant cause of the failures. Failures of some sections of pervious concrete should be anticipated with construction. About 3% of the pervious pavement on the RW Johnson project had to be replaced.
- The PercoCrete concrete mix used by the City for several years has been found to have poor durability. Fortunately, pervious concrete mix designs have significantly improved in recent years. Risks taken with earlier projects are diminishing as the industry gains experience.
- The surface of the pervious concrete bike lanes is not as smooth and uniform as anticipated. Some bike commuters have commented that they avoid these lanes.
- The design also is more sensitive to clogging of the surface pores than traditional permeable pavement designs. The flow of runoff from the rest of the roadway surface onto the pervious bike lane transports fines and sediment. Even with regular sweeping and cleaning it is difficult to keep the pervious pavement clean. However, the pavement is still effective due to use of the high fines PercoCrete pervious concrete.

### Northeast Neighborhood Rain Garden

Located on the west side of Fir Street NE at the intersection with Oak Avenue NE, this approximately 400 square foot rain garden was installed in 2010 in cooperation with members of the Northeast Neighborhood Association. The rain garden is located on sandy soil and was compost amended prior to planting.

### Successes

- Nearby neighbors have agreed to weed and water the rain garden when necessary.
- In the year since installation, the rain garden has functioned as designed and has not held water for more than a 24 hour period.
- Water Resources positively engaged with an active neighborhood association and we continue to explore possibilities for future rain gardens in the neighborhood.

### Challenges and Lessons Learned

- The location first chosen for the rain garden was ultimately discarded because of conflicts with an existing gas line. A preferred location for rain gardens is often adjacent to the road edge; however this is also frequently the location for utility lines.
- The rain garden was ultimately located in an unopened public right-of-way (the westward continuation of Oak Avenue NE) and therefore neighborhood volunteers were unable to perform the installation work because city policy requires work performed in the right-of-way to be bonded and insured.
- Finding landowners willing to have rain gardens on or adjacent to their property can be a challenge.
- Rain gardens require ongoing maintenance (weeding, watering, debris removal) to ensure stormwater treatment and flow control functions. These activities can be performed by adjacent property owners or city staff; both options have benefits and drawbacks.

### Green Cove Basin LID District

In October 2001, the City of Olympia adopted a unique zoning district and associated set of mandatory low impact development regulations within a single watershed for the purpose of preventing further damage to aquatic habitat from urban development. A comprehensive set of policy revisions covering development density, impervious surface coverage, lot size, open space/tree retention, street design,

street width, block sizes, parking, sidewalks, and stormwater management requirements were enacted. Since that time there has been some development in the basin and staff has learned what has worked as envisioned, as well as what hasn't.

### Successes

- Olympia's authority to create a special zoning district and codes for unique, environmentally sensitive areas was utilized. Taking the leap from voluntary to mandatory LID requirements is rigorous and labor-intensive, but feasible.
- Significantly increasing tree retention requirements has provided large dedicated tree tracts, typically around the periphery of the developments. The scale of the tracts successfully protects native species and soil conditions.
- Street design follows LID principles. Street layout includes large blocks, topographically-sensitive configurations, narrow pavements, limited sidewalks, and traffic calming.

### Challenges and Lessons Learned

- Implementing the mandatory subdivision and individual parcel LID requirements during construction proved difficult. Commonly, developers and constructors were not willing to meet the requirements. City project management and inspection practices were also inadequate.
- Some residents felt they were buying into a unique and environmentally sustainable development only to find that housing densities and disturbance to developed areas of the site remained high.
- Eighteen-foot wide streets provided to be a little too narrow. The standard City local access street width of twenty feet is preferable with minimal environmental implication.
- Soil and vegetation protection areas located along adjoining back yards were not supported by homeowners. The areas have been assimilated into yards.
- Building rain gardens on individual lots was challenging. Lot sizes are small and dominated by other above as well as below ground uses.

## LID in Other Cities

Staff conducted phone discussions with eleven cities to gain an understanding of the status of their LID programs and learn what incentives or regulations they have found successful. Nine discussions were with northwest cities regulated under a Phase 1 or Phase 2 NPDES permit. Two of the discussions were with similarly sized cities using LID elsewhere in the nation. Attachments 5 and 6 summarize at a glance the LID techniques and LID promotion programs at work in the contacted cities. The purpose of these discussions was to provide anecdotal information from similarly sized and regulated cities rather than a scientific status evaluation of the communities. As you'll see from the comparison table, Olympia differs from some of the other communities in that we do not currently have a green development team or offer pre-approved standard plan sets for LID. Both of these are good tools to consider developing for Olympia. Also differing from Olympia, a few communities have rate reduction programs for properties that install LID features. The general feeling from those cities, however, is that the money saved by the property owner is too small to offer much real incentive.

### Trends

- All of the contacted communities are frequently seeing the use of pervious pavements for sidewalk and/or parking area settings.
- Rain gardens on private and public lands have been installed with varying success in all communities.

- Washington communities all stated the State's upcoming LID permit requirements as a major driver of the future direction of LID in their city.
- The cities of Seattle, Tacoma, Portland, Bellingham and Burlington have rate reduction programs for properties that implement LID. Seattle only targets large parcels that have a major impervious surface. Tacoma feels their allowed reduction is too small to be much of an LID incentive.
- The only communities driven to implement LID by combined sewer overflow (CSO) concerns were Seattle and Portland. Other communities cited council/mayor or staff interest as the primary impetus for their LID efforts.
- Most communities are using a mix of voluntary and regulatory tools to implement LID. Results have shown a greater impact through the use of regulatory tools.
- Citizens want assistance to implement LIDs on their property through financing, material supplies, expertise, and/or labor.
- More than half of the communities mentioned the connection between LID and green building efforts in their city. Both LEED and the Sustainable Sites Initiative award points for innovative stormwater practices.

## Successes

- Bellingham endeavors to include LID in some capacity as much as possible into their capital projects.
- Last year Bellingham instituted their "Bin Bump-Up" program, which provides faster project review timelines for development applications that are attempting LEED Gold certification or better. As an example, if a project typically has a four week review timeline, under the "Bin Bump-Up" program it would be guaranteed a two week review. They have found this to be successful and an incentive. Kirkland has implemented a similar program, and found it successful; however, less so in the currently slow development climate. Olympia also allows green projects to jump to the front of the queue.
- Puyallup recently retrofitted a residential block with porous asphalt, permeable paver sidewalks, and rain gardens in the public right-of-way to capture excess stormwater runoff from driveways, sidewalks and the road. Named the "8th Ave NW LID Retrofit Project", the neighborhood has well-draining soils and community support for the project.
- Portland accounts its LID successes to its multi-disciplinary approach in each case. The greatest results are from new development requirements and applying green technologies to capital improvement projects.
- Seattle's "Green Factor" program has been successful due to the inclusion of all disciplines in its program development process. One popular difference is the efficiency outcome caused by the need to include landscape architects earlier in the design process.

## Plans for the Future

- Puyallup has plans to increase their use of pervious pavement with a demonstration alley conversion.
- Portland has just started its Grey to Green Initiative. It expands on stormwater management techniques that mimic natural systems. The areas include land acquisition, green streets, ecoroofs, trees, culvert replacement, revegetation, and invasive plant removal.
- Seattle recently launched its Rain Wise program. Seattle residents can use this web-based tool to explore different green stormwater solutions for their property, see what others are doing or find a contractor.

## Upcoming WDOE LID Requirements

The Washington Department of Ecology has released a draft Phase II permit along with a draft of the new Stormwater Management Manual for Western Washington (drainage manual) for public review. While not the final permit, requirements in the draft documents will likely be quite similar to the final permit. The permit's approach addresses structural LID (e.g., permeable pavement) through regulations in the revised drainage manual. Non-structural LID techniques (e.g., subdivision standards) are required to be incorporated into local codes and standards using a defined collaborative process.

Ecology primarily revised the drainage manual to require inclusion of LID stormwater techniques in new development and redevelopment. The intention is to achieve LID stormwater designs that mimic the natural drainage processes by using stormwater site design and best management practices that retain vegetation, limit impervious surfaces, and infiltrate runoff on-site.

The draft permit proposes to set goals (a hydrologic performance standard) and standards for LID (a menu of approved LID best management practices) while providing a variety of tools and some flexibility for meeting them. All sites will be subject to feasibility criteria that can reduce LID requirements; such as, where soils are too poor to infiltrate runoff; where there is insufficient depth to groundwater; or where there are insufficient setbacks from structures or sensitive areas.

## Evaluation of LID Techniques

In an effort to evaluate the strengths and challenges of specific LID techniques for Olympia, Attachment 2 was created. The techniques are grouped into LID applications appropriate for a subdivision layout, the area within the right-of-way, and those pertaining to individual lots. This table builds on the previous Barriers to Low Impact Development Report developed by staff in early 2011 and indicates future direction for possible code and policy changes. Staff found that some LID techniques are quite well incorporated into existing City codes and standards, while others are not and will require future work. Of the techniques not yet incorporated, some appear more effective or feasible than others and should therefore be prioritized. These items are bolded in the last column of Attachment 2 and indicate where staff recommends focusing future work efforts. Strengths and challenges particularly pertinent to Olympia are also bolded in the table.

Details and full implications of proposed changes will need to be discussed with other affected departments. Any modifications to adopted City codes and standards (OMC, EDDS, Olympia Drainage Manual) require a full public review process. The new Phase II permit will require Olympia to complete all code changes by the end of 2016. Staff anticipates completing code amendments prior to the deadline, with specific timing to coincide with other scheduled periodic updates to City code and design manuals.

In addition to further refining Olympia codes and standards, in 2012 staff will continue the work related to supporting and incentivizing rain gardens, replacement of failed pervious pavement, development of standard specifications for LID installations, and improvements to LID outreach on the city's website.