Department of Ecology – Water Quality Program
Development of Low Impact Development (LID) Standards for the Municipal Stormwater General Permits

Technical Advisory Committee Meeting #2
December 9, 2009, 10:00am–3:00pm at Federal Way City Hall Chambers
MEETING SUMMARY

Goal of the Meeting: The goal of this meeting was to follow up on Ecology's proposed permit framework, and discuss methods for the definition of hydrologic performance standards.

AGENDA

Introductions and Agenda Review

Review and update of LID goal and definition

Proposed Permit Framework as context for performance standard discussion

Hydrologic Performance Standards – Technical Basis

- Attributes of a good performance standards
- Options for consideration
- Factors to consider
- Schedule and off ramps

Feasibility of LID Techniques and Development Principles

Next Meeting — Agenda, modeling requests, and preparation

ATTENDEES

A list of attendees is provided at the end of this meeting summary.

TRANSCRIPTION OF FLIP-CHART NOTES

The meeting summary provided here is a transcription of the flip-chart notes taken by Kate Snider during the meeting. This does not provide a full documentation of the dialogue, but provides a record of the primary input received from the attendees.

Comments on LID Goals

The TAC and IAC have been working on a clear definition of LID and associated goals. The working document was reviewed for further input by the TAC.

- Change the 2nd sentence of the LID Goal to read ". . . and to reduce past hydrologic changes on aquatic systems through redevelopment and retrofit?" The reference to "existing development" is confusing
- The goal should reference improving water quality or protecting aquatic life.
- Concern that we are narrowing the focus to hydrologic effects only
- Goals statement should relate to "disturbance of watershed processes".
- Goals should include:
    - Prevent or improve hydrologic impacts
    - Reduce or prevent pollution
    - Reduce harm to or improve conditions for aquatic life

Comments on LID Definition

- Remove reference to specific technology (for instance water reuse).
- Could rephrase so that technology references are brought down below, e.g. "Strategies include…"
- Remove "rainwater harvest and rainwater reuse" and just include water reuse up with infiltration etc.
- Water quality should also be in the definition of watershed processes – bring down below

Comments on Permit Framework Document

A draft Permit Framework document was provided prior to the meeting for review by the TAC. The Permit Framework document was put forward by Ecology to stimulate discussion and comment. It was also discussed at the IAC #1 meeting.

- Concerns regarding the discussion in the Framework of "eventually requiring municipalities to revise development codes". Code changes will be needed to implement any LID. Ecology needs to hear from local governments on the logistics for stormwater code and development code revisions. Should it be a 1-step or 2-step process? That is a key discussion planned for the next IAC meeting.
- The conditions that could trigger the need for different performance standards include:
    - New development vs. redevelopment
    - Land use types: residential, commercial, and industrial
    - Level of density
    - Historic use (contaminated soil)
    - Adjacent features e.g. to steep slopes

- Concerns were voiced regarding different performance standards for different densities. Want everyone to meet the same standard.
- Consider the interplay between the performance standard and feasibility. One stringent performance standard with off-ramps may be the simpler way to go.
- Does hydrologic modeling reflect the change in evapotranspiration? And reflect the destabilization of streams? How does the model detect the effect on watershed health? If add just a small percent of impervious surface area, it affects the health of aquatic species.
- Consider whether hydrologic models are a good way to determine whether LID goals are met.
- Different performance standards for different uses? May be necessary to have a different hydrologic performance standard for redevelopment, in order to emphasize redevelopment preference over new development.
- An alternative to setting hydrologic performance standards would be to have requirements to limit effective impervious area and maintain native vegetation.
- Directly regulate changes in evapotranspiration and effective impervious area such as 65/10.
- We would be better off to start with one performance standard with off-ramps and then determine if another performance standard was necessary.
- Be cautious of setting multiple performance standards.
- Concerns regarding the difference between how well certain techniques will perform compared to the targets in the model. We may be able to achieve more with certain techniques (e.g. permeable pavement) than we have been considering in the models. Concerns again were voiced about having different standards for different types of development. Prefer one performance standard with off-ramps for redevelopment and site conditions.
- Concern whether volume and duration will protect the watershed.
- Be careful with requiring one performance standard. Need to recognize different site conditions.
- Understand there will be obvious agreed off-ramps but don't get too specific.
- We need to have off-ramps for redevelopment projects because of site conditions, e.g. contaminated soil.
- Make sure that if one performance standard is used it is not so compromised that we don't achieve watershed health.
- Concern was voiced regarding the initial and long term standards.
- Ecology will have to require the code changes
- Comments on the "Key Issues" listed at the end of the Permit Framework Document:

- Permit should require LID "everywhere" even for flow exempt watersheds.
- There should be requirements for small properties such as single family homes.
- Minimum requirements should apply to smaller sites

Possible Hydrologic Performance Standards

Ed O'Brien reviewed alternative technical methods for defining hydrologic performance standards, per the handout "Possible Hydrologic Performance Standards" provided in advance of the meeting. Additionally, Ed handed out runoff curves used to clarify Option 2 – Runoff Flow Rate Duration Basis (Attached). TAC discussion was had on the proposed methods:

- No matter what technique is used, should the standard compare to:
  - Natural conditions;
  - Conventional development; or
  - Existing conditions?
- Note: "runoff" (in Ed's flow comparison graphs) = runoff + interflow
- There were several questions about the variables used to produce the runoff curves. Ecology to provide backup. (See attached duration curves and assumptions).
- Option #3 is the simplest but if used would need to very carefully define the "conventional development" requirements so that the methodology is not misused. Concern regarding how effective these requirements would be at protecting resources.
- Option #1 does not account for "distributed" requirements for stormwater.
- Since the hydrologic performance standard is not addressing water quality treatment directly, there should be a volume component. Volume reduction = load reduction
- Should set good performance standard but also define how to get there: define performance standard and define suggested LID techniques.
- Proposal for alternative standard: Should match both interflow and overland runoff of the pre-development conditions – don't combine them into one runoff value.
- The Option #3 approach does not make sense at small sites. Therefore, not a preferred option.
- Should use annual runoff volume reduction at the lower range of durations. What kinds of reductions do we get with current modeling methods? What are the assumptions and credits for existing technologies? Should look at the numbers and make a decision whether to use volume only.
- Acknowledge that there are concerns around the table regarding current modeling assumptions re: performance of LID techniques.
- For large development, Option #3 provides some credit for BMPs that slow flow.

- If Ecology goes with Option #1 -- What would be the 'tier 2' for redevelopment or high density properties?
- Need a different standard for small developments (< 1 acre) and for redevelopment properties, and in poorly infiltrating soils.
- Approve of the EPA standard because it retains 100% of the stormwater on site. And would like to learn more about it.
- Should tweak Option #2a to capture more frequent storms than 50% of 2 year in combination with some sort of volume standard. How can we do that with continuous modeling?
- Interested in the distinction between interflow and overland flow in the pre-development and post-development comparison.
- Volume reduction = pollution load reduction.
- Avoid increasing the potential for downstream geologic hazards.
- Curious whether extending the duration curve addresses volume standard.
- Would like to see comparison to the EPA approach.
- It needs to be easy to understand and implementable.
- Concerned that we don't get much when extend the duration curve to lower flows.

Public Input

- The standard Ecology needs to meet is:
    - Does it protect the resource?
    - Does it require LID to the maximum extent technically feasible?
- LID is a completely different approach to development. PCHB recognized this and made the ruling.
    - Essential that native vegetation retained and impervious surface reduced.
- Address refinements to baseline modeling. Will model refinement help better mimic site conditions?
- Must change development codes in the beginning regarding clustering, road widths, etc.
- Need more understanding of other processes in addition to infiltration (e.g. evapotranspiration) for modeling of LID Facilities.
- Need better modeling and a better understanding of transpiration and capillary action in soil and vegetation.
- Provide citations to performance standards from other states that were listed on the performance standards handout

- As a Phase II city, we need an implementation process that gets us using early BMPs now, while code changes for development are being worked out.
- Concern about pushing water into shallow soils. The current model does not accurately reproduce interflow.
- Start with small steps and then bigger steps to bring developers along gradually.

Feasibility of LID Techniques and Relationship to Performance Standards

- For one performance standard there is a balance between a barely achievable standard that few can meet and one with too much compromise so that everyone can meet the bar.
- Residential density can increase vertically to meet an aggressive performance standard.
- A single standard is achievable, but development will look different. Avoids the chaos that multiple standards will cause.
- Site layout and development principles are critical to meet LID goals

  Barriers include:

  - The development code
  - Designer experience – there has been progress in designing more compact creative site design, but still a challenge to find a willing designer.
- Whether one standard is implemented, or a very judicious set of multiple rigorous standards, we should push aggressively for denser development.
- Set one hydrologic performance standard and provide prescriptive attributes for elements. For instance, in addition to meeting the new performance standard set other requirements such as retaining a minimum percent of native vegetation.
- Move to a more aggressive hydrologic performance standard, bring a volume requirement and added attributes requirements in.
- Ecology should set a performance standard, and allow the municipalities to determine how to meet it. This approach will allow changes as technologies evolve.
- Set a performance standard at the maximum extent feasible. Push really hard to get the maximum. But if we go this way we would need clarity around the requirement to get as close as possible to meeting the standard.
- How do we set requirements for small sites which are exempt from flow control requirements? How do we size the features?
- Use the example of the City of Seattle's approach to use LID to max extent feasible.
- Recognize that there is a large range of variation between Greenfield to urban redevelopment.
- City of Seattle "off-ramps" include: technical feasibility, spatial constraints, economic feasibility

- Puget Sound Partnership approach required attributes of retaining native vegetation and reducing effective impervious surface as essential components.
- Emphasize the linkage to the impact to the resource.
- Make sure we have the ability to meet the goals on small sites. What can we push for on properties of less than 1 acre?
- Ecology position: Need to be able to set clear performance standards; have consistency in modeling; consistency in decision making re; feasibility; flexibility for municipalities regarding implementation.
- Basin planning and relationship to development - need a place for vegetation retention requirements to protect resource.

Model Scenarios

The Ecology Team intends to perform a set of hydrologic modeling runs prior to the next TAC meeting in order to provide specific examples of what it would take to meet various performance standards. TAC input was received on the modeling scenarios that would be most helpful to evaluate.

- Sensitivity regarding the performance of pervious pavement? We are achieving better performance than the models currently acknowledge.
- Model pervious pavement as infiltration (assumes low slope).
- Model for different scenarios with clear descriptions of assumptions for each scenario.
- Provide a diagram of what the development and LID Techniques would include that are necessary to meet the performance standards in each scenario.
- Soil types: Evaluate zero infiltration (glacial till at 0.002 to 0.003 permeability) and 2 inches per hour (glacial outwash).
- High groundwater: Infiltration is feasible if highly permeable soil type, not feasible if it overlies till.
- Use a range of locations for rainfall. Wet to dry extremes.
- Curtis Hinman will share the modeling he's already conducted – bioretention on single family lots under different rainfall conditions.
- In addition to other options, show what is needed to meet Ecology Flow control standards for comparison? (This is not a high priority for Ecology because the LID requirements must go beyond)
- Model both flat and sloped sites.
- Model residential to urban property.
- Model results of implementing feasible LID techniques; and separately add implementation of the "development principles".

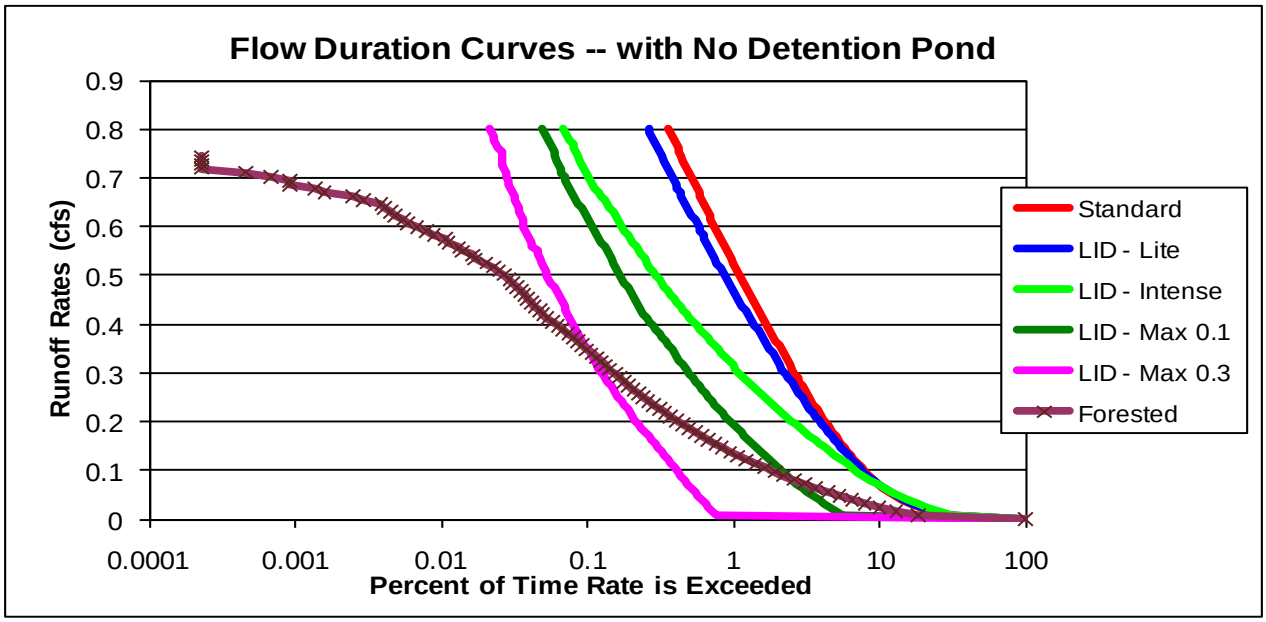
- Model with porous pavement within public rights of way, and without
- Compare to the EPA standard. See what takes to meet it and what those LID methods would result in with a continuous model method.
- SVR will define basic alternatives and get input from Ecology and the TAC members who want to provide specific modeling input

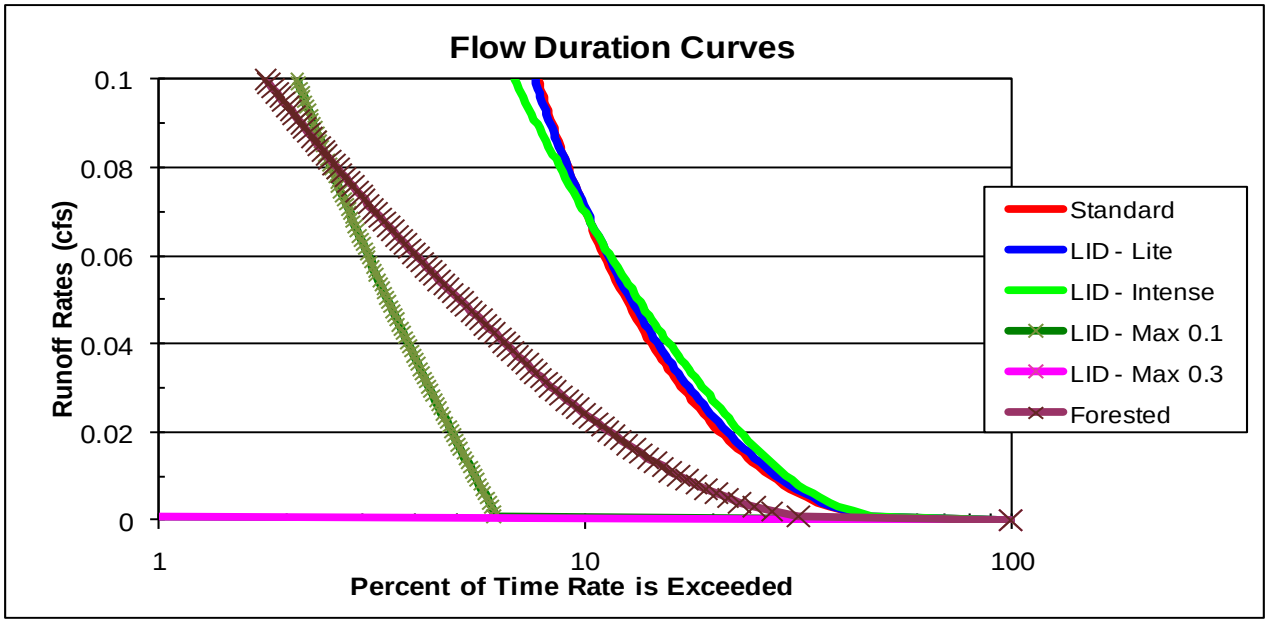
Input on Agenda Items for Next TAC Meeting

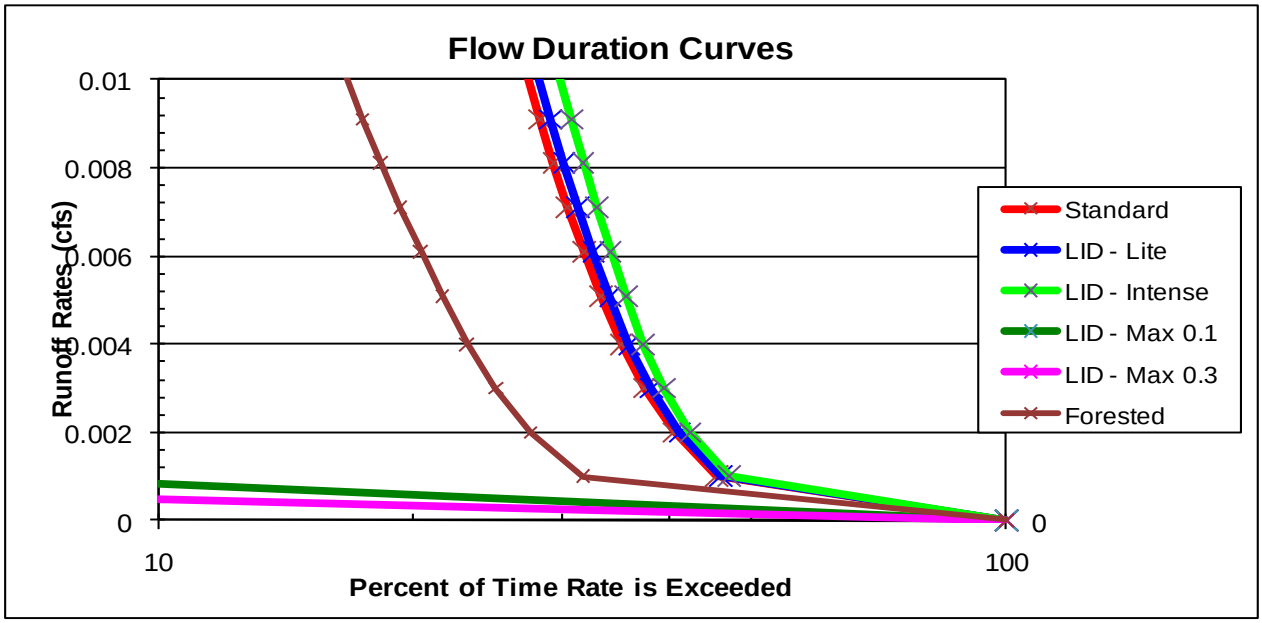
- Present and discuss the lessons from modeling
- Discuss other ways to require LID:
    - Not a hydrologic performance standard
    - Prescriptive measures
- More fully discuss determination of feasibility and off-ramps
- Discuss issue of LID requirements in flow-control exempt watersheds

Public Input

- Not sure the Performance Standards get at the definition of “distributed” facilities
- How do you address sites that can do more, through conventional technologies, to protect the resource?
- There should be no flow control standards on dammed rivers?
- Model what is protective of the resource: Zero surface runoff, should match forested conditions
- Concerns regarding use of the term “maximum extent feasible” at today’s meeting. The PCHB decision reads simply “where feasible”.


Flow Duration Curves -- with No Detention Pond
Runoff Rates (cfs)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.0001
0.001
0.01
0.1
1
10
100
Percent of Time Rate is Exceeded
Standard
LID - Lite
LID - Intense
LID - Max 0.1
LID - Max 0.3
Forested


Flow Duration Curves
Runoff Rates (cfs)
0.1
0.08
0.06
0.04
0.02
0
1
10
100
Percent of Time Rate is Exceeded
Standard
LID - Lite
LID - Intense
LID - Max 0.1
LID - Max 0.3
Forested


Flow Duration Curves
Runoff Rates (cfs)
0.01
0.008
0.006
0.004
0.002
0
10
100
0
Percent of Time Rate is Exceeded
Standard
LID - Lite
LID - Intense
LID - Max 0.1
LID - Max 0.3
Forested

Residential Development Examples:

Example 1 – Highlighting benefits of individual IMP's

10 acre residential subdivision; 46 homes on individual lots

Till Soils:

Example 1A – Standard development
1B – LID Lite
1C – LID Intense
1D – LID Max

Outwash Soils:

1E – Standard development w/o dry wells
1F – Standard development w/ drywells
1G – LID
1H – LID Max

Example 2 – Highlighting Better Site Design and Forest Retention

23.92 acre residential subdivision; 103 homes on individual lots; till soils

Example 2A – Standard Development
2B – Std. Development with native vegetation preservation per lot
2C – LID (Reduced development envelope)

Example 1A: Standard Development: Till

See Layout; Gross density: 4 homes/acre; 46 homes/11.2 acres
Note: In examples, as the pond area shrinks, the saved land area is converted to "Landscape" so that the project area remains at 11.2 acres.

Design details:

Subdivision road: 56,000 sq. ft.: 28' x 2,000' = 1.28 acres
Lots vary around 8,250 sq. ft.
Roof area: 3,200 sq. ft.
Driveway: 500 sq. ft.
Private walk: 75 sq. ft.
Sidewalk: 425 sq. ft.

WWHM Basin Screen:

Impervious Area (Roofs):	3.38 acres	3,200 x 46 homes
Streets, Sidewalks, Parking:	2.34 acres	1.28 road + 1.06 walks/driveway
Landscaped Area	4.78 acres	4.28 on lots + 0.5 around sw pond
Pond	.7	estimate for pond surface area
Total	11.2 acres	

Result:

Pond Area: 0.73 acres
Pond Volume: 3.98 ac-ft

Example 1B: Low Impact Development – Light:Till

LID Features:	**LID Credit:**
Reduced width road: 20'x 2,000' = 40,000 sf (0.92 ac)	0.37 ac converted to grass
Driveway and Walks in porous asphalt and concrete:	50% grass, 50% impervious

WWHM Basin Screen:

Impervious Area (Roofs):	3.38	
Streets, Sidewalks, Parking:	1.44	0.92 (road) + 0.53 (walks/driveway)
Landscaped	5.68	4.78 + 0.53 + 0.37 (road conversion)
Pond	.7	for pond surface area
Total	11.2 acres	

Results:

Pond Area: 0.61 acres
Pond Volume: 3.24 ac-ft

Example 1C: Low Impact Development-Intense: Till

LID Features:	**LID Credit:**
Reduced width road as above	0.37 ac converted to grass
Driveway and Walks in porous asphalt and concrete:	50% grass; 50% impervious
Subdivision road in porous asphalt	100% grass
Vegetated Roofs: 4 inch depth	50% grass; 50% impervious

WWHM Basin Screen:

Impervious Area (Roofs):	1.69	½ roof area to Landscape
Streets, Sidewalks, Parking	0.53	only ½ area of walk/driveway
Landscaped Area	8.48	4.28 lots + 0.7 sw pond grass + 0.53 walk/drive + 0.92 road + 0.37 road red. + 1.69 roofs
Pond	0.5	
Total	11.2 acres	

Results:

Pond Area: 0.46 acres
Pond Volume: 2.34 ac-ft.

Example 1D: Low Impact Development-Max: Till

LID Features:	**LID Credit:**
Reduced width road as above	0.37 ac converted to grass
Driveway and Walks in porous asphalt and concrete:	50% grass; 50% impervious
Subdivision road in porous asphalt	100% grass
Vegetated Roofs: 4 inch depth	50% grass; 50% impervious
Bioretention Swale; both sides of road	model as an infiltration pond

No underdrain; overflows to elevated storm drain
Length: 2,000 feet x 2 (both sides) - 767 (46 lots x driveway width) = 3,233 ft
Width: 6 ft
Effective Depth: 0.75 ft standing water + 2 ft. soil x 0.4 (voids) = 1.55 ft
Shape: vertical sides
Infiltration rate: based on underlying till. Used 0.1 and 0.3 inches/hr

WWHM Basin Screen for Lots:

Impervious Area (Roofs):	1.69	½ roof area to Landscape
Streets, Sidewalks, Parking	0.53	only ½ area of walk/driveway
Landscaped Area	7.32	8.48 - .92 - .44 + .2 sw pond
Ponds	0.74	0.44 swale + 0.3 sw pond
SubTotal	10.28 acres	

WWHM Basin Screen for Rd:

Landscaped Area	0.92

Total Project Area 11.2 acres

Pond Information/Design Screen

Length: 3,233 feet
Width: 6 feet
Effective Depth: 1.55 feet

Results: For Infiltration rate of 0.1 in/hr
Pond Area: 0.37 acres
Pond Volume: 1.8 acre – ft

Results: For Infiltration rate of 0.3 in/hr
Pond Area: 0.23 acres
Pond Volume: 1.03 acre-ft

Example 1E: Standard Development: Outwash without Roof Dry Wells

Design details:
Subdivision road: 56,000 sq. ft.: 28' x 2,000' = 1.28 acres
Lots vary around 8,250 sq. ft.
Roof area: 3,200 sq. ft.
Driveway: 500 sq. ft.
Private walk: 75 sq. ft.
Sidewalk: 425 sq. ft.

WWHM Basin Screen:

Impervious Area (Roofs):	3.38 acres	
Streets, Sidewalks, Parking:	2.34 acres	1.28 road + 1.06 walks/driveway
Landscaped Area	5.08 acres	4.28 on lots + 0.8 pond set aside
Pond	0.40 acres	
Total	11.20 acres	

Pond Information/Design Screen:
Measured Infiltration Rate: 8 inches/hour
Infiltration Reduction Factor: 4 (enter as 0.25 in WWHM)
Effective Depth: 4 feet

Result:
Infiltration Pond Surface Area: 0.40 acres
Volume: 1.31 ac-ft

Example 1F: Standard Development: Outwash with Roof Drywells

All roof runoff goes to dry wells; DO NOT ENTER INTO COMPUTER MODEL
Infiltration Pond has 3 foot depth, with 1 foot freeboard

WWHM Basin Screen:

Impervious Area (Roofs):	0 acres	All roofs to drywells
Streets, Sidewalks, Parking:	2.34 acres	1.28 road + 1.06 walks/driveway
Landscaped Area	4.61 acres	4.28 on lots + 0.33 pond set aside
Pond	0.17	
Total	7.12 acres	

Result:
Infiltration Pond Surface Area: 0.17 acres = 7,400 square feet
Assume 4' max. depth infiltration pond

Example 1G: Low Impact Development: Outwash

LID Features:	**LID Credit:**
Reduced width road as in Ex. 1C	0.37 ac converted to grass
Driveway and Walks in porous asphalt and concrete:	50% grass; 50% impervious
Subdivision road in porous asphalt	100% grass
Roof downspouts to dry wells	Do Not enter into WWHM

WWHM Basin Entry Screen:

Impervious Area (Roofs):	0	
Streets, Sidewalks, Parking	0.53	only ½ area of walk/driveway
Landscaped Area	6.23	4.28+0.53+0.37+0.7-0.07
Pond	0.07	
Subtotal	6.83 acres	

Result: Pond Surface Area: 0.07 acres = 3,050 square feet

Example 1H: LID – Max: Outwash

LID Features: **LID Credit:**

Same as 1G

Bioretention cells for 2 lots each (23 total) — Model as an infiltration pond

- No underdrain
- Road drainage enters bioretention cells via curb cuts
- Length: 10' X 23 cells = 230 total length
- Bottom width = 16'
- Effective Depth: 0.75 ft of maximum water depth.
  - Note: The estimated long-term infiltration rate of the imported soil because is lower than the estimated initial infiltration rate of the underlying outwash. So, do not include the void space of the imported soil in the effective depth.
- Shape: vertical sides for soil; 9 inch water depth can be sloped
- Infiltration rate: based on soil imported for bioretention. See text for guidance; Assumed initial infiltration rate of 2 inches/hour.
- Infiltration Reduction: Use a factor of 2 (In WWHM, enter 0.5 as "Infiltration Reduction Factor.") Drainage area to each cell does not exceed 10,000 sq. ft. impervious, or 5,000 sq. ft. PGIS, or ¾ acre pervious)

Pond Information/Design Screen: Enter above data as shown for Example 1D

WWHM Basin Screen:

Impervious Area (Roof)	0		
Streets/Sidewalk/Parking	0.53	acres	½ area of driveways/walks
Landscaped Area	6.216	acres	Same as 1E w/ smaller pond
Pond (total cell area)	0.084	acres	16' x 10' x 23'
	6.83		

Result: Centralized Infiltration Pond not needed

Example 2A: Standard Development on Till

23.92 acre residential subdivision; 103 homes on individual lots; 4.3 lots/acre
See Slide for Assumed layout
Area for Detention Ponds is considered additional to the 23.92 acres.

Design Details:
Subdivision Road:
Length: 3,600 ft Width: 32 feet
Lots vary around 7,500 sq. ft.
Roof area: 1,650 sq. ft.

WWHM Basin Screen:

Roofs:	3.90 acres
Streets/Sidewalks	4.00
Landscaped area	16.02
SubTotal	23.92 acres
Pond area	1.2
Total Area	24.92 acres

Result: Pond Surface Area: 1.2 acres
Pond Volume 7.1 ac – ft

Example 2B: Native Vegetation Retention on Individual Lots

Design Details:
23.92 acres with the same number of lots as Example 2A. This example is intended to show the effect of preserving 38% of the land in forest by reducing the landscaped area on each lot. Individual Lot sizes stay the same. This example is not very practical.

WWHM Basin Screen:

Roofs:	3.90 acres	
Streets/Sidewalks	4.00	
Landscaped area	7.02	9 acres preserved in Forest
Subtotal	14.92	Do not enter forest acreage in the pre- or post-development basin screens
Pond Area	1.0	
Total Area	15.92	

Result: Pond Surface Area: 1.0 acres
Pond Volume: 5.94 ac-ft.

Example 2C: LID W/ Better Site Design

Design Details:
103 homes on 23.92 acres, but lot sizes reduced. See slide for layout.
The 38% of land preserved in native vegetation.
Pervious Pavement on roads, driveways, and patios.
With pervious pavement, each lot has 2,025 impervious area:

Roofs:	1,650	
Driveway:	500/2 = 250	because modeled as ½ impervious, ½ landscaped
Patio:	300/2 = 125	because modeled as ½ impervious, ½ landscaped

With 38% native vegetation, up to 5.75% of site can be impervious and be dispersed into the native vegetation area:

23.92 acres x .0575 = 1.375 acres = 59,895 sq. ft.

59,895 impervious area/2,025 impervious area per lot = 29 lots that can be "fully dispersed" into the native vegetation area as a way to meet the stormwater requirements for those lots. However, the forest retention and adjacent development layout does not lend itself to utilizing all forested areas for full dispersion due to drainage patterns and minimum need for 100 feet of native vegetation flow path. This example assumes 18 lots can be "fully dispersed." Therefore subtract the impervious and pervious areas of 18 lots from the WWHM Basin input file.

1,650 sq. ft./roof x 18 roofs = 0.68 acres fully dispersed
800 sq. ft./patio & driveway x 18 lots = 0.33 acres fully dispersed.
1,693 landscaped area/lot x 18 lots = 0.70 acres full dispersed

Subdivision Road:
Length: 3,700 ft Width: 21.5 feet

WWHM Basin Screen:

Roofs**:**	3.90 – 0.68 = 3.22 acres	
Streets/Sidewalks/Parking:	0.95 - 0.33 = 0.62 acres	Note entire road moved to landscaped category
Landscaped:	7.02 + 3.05 - 0.70 = 9.37 acres	
Subtotal	13.21 acres	
Pond Area	1 acre	
Total Area	14.21 acres	

Notes: 9 acres of forest and 1.71 acres of "fully dispersed" developed area are not entered into the WWHM. Therefore, use 14.21 acres as the pre-developed – forested – land cover condition to which the developed sites high flow durations must be matched.

Result: 0.61 acres
3.26 acre-ft