COASTAL SMART GROWTH

The Practice of LOW IMPACT DEVELOPMENT

Implementing a Low Impact Development (LID) program requires more than simple commitment, or even passage of a bylaw. It requires a change in the practice of planning and the review of development plans. Without this change, the full potential of LID cannot be reached. The question is, how do you go about implementing LID in practice?

LOW IMPACT DEVELOPMENT REVIEW

To briefly review, LID is a more sustainable land development pattern in which site planning focuses on preservation of the natural resources and maintenance of the natural hydrology of a site.

In conventional sprawl development, destruction of natural features and introduction of large impervious surfaces reduces infiltration of water into the ground and necessitates large structural stormwater controls, such as catch basins, pipes and detention ponds to mitigate flooding. LID, in contrast, seeks to preserve natural features and relies on thoughtful site planning and the use of a broad range of design techniques, such as clustering, permeable surfacing materials, and bioretention to reduce the level of impervious cover and address the quantity and quality of stormwater drainage. Natural drainage pathways and open space are preserved, and the overall impact from development is significantly reduced.

LID IN PRACTICE

In practice, LID is a site planning process, including a site assessment phase and a site design phase, intended to minimize impacts of development and conserve natural resources, combined with a particular approach to selecting structural Best Management Practices (BMPs) to mitigate remaining stormwater impacts.

A. SITE ASSESSMENT

The site assessment phase may well represent the greatest departure from conventional development practice. In LID, before a development is laid out, the hydrologic functioning and environmental resources and constraints of the existing parcel are carefully identified and mapped. The mapping of these areas reveals "building envelopes"—areas that can support development, both economically and ecologically. The site assessment should result in an existing conditions/site analysis map that will:

1. Identify environmental resources and constraints on the site. These may be divided into "primary" conservation areas protected under local, state, and federal law (i.e., wetlands, rivers, drinking water protection zones) and "secondary" conservation areas, such as areas with well-developed native vegetation, vegetated buffers, scenic views, steep slopes, and erodible soils. *For more information:* http://www.mass.gov/czm/smartgrowth/lid/index.htm.

2. Identify current hydrologic conditions (i.e., permeable and impermeable soils, vegetated areas) and document natural or existing drainage systems.

3. Establish building envelopes where development can occur with the least impact (often uplands, ridge lines, and gently sloping areas) and delineate construction disturbance envelopes so that no unnecessary clearing, grading, or disturbance occurs.

4. Identify locations for effective infiltration/other BMP placement.

For local officials implementing an LID program, there is a need to develop a clear process for local involvement in site assessment and design. For example, local officials can encourage developers to schedule a pre-application review meeting. The developer should be told to bring both a site context map and a preliminary existing conditions/site analysis map to this meeting. With this preliminary data, the Planning Department, Conservation Commission, DPW, and other appropriate departments work with the developer at this meeting to determine what features should be preserved and what areas are suitable for development. This will begin a "design partnership" with the developer to preserve open space, cluster buildings, and minimize impervious surfaces. This process will not only increase the success of the LID program, but also reduce the developer's cost of engineering and plan revisions by commencing negotiations on the design with the Planning Board at the earliest possible stage in the development. This type of collaborative process is now used by the town of Franklin in the implementation of their Best Development Practices Guidebook. See *LID Case Study: Franklin* for an example of a successful effort to guide Low Impact Development and create a more constructive development review procedure.

B. Site Design

Once the building envelopes have been established, site design commences. The overarching goal of LID site design is to minimize the impact of development by maintaining, to the greatest extent possible, pre-development hydrologic conditions on the site for both water quantity and quality.

There are numerous LID site design techniques, or "nonstructural LID-BMPs." They can be grouped into five categories:

- Preservation and Clustering
- Maintenance and Use of Natural Drainage Systems
- Disconnection of Impervious Surfaces
- Minimization of Impervious Surfaces
- Planning for Effective BMP Selection and Placement

1. Preservation and Clustering

Potential site development layouts should be prepared using the nonstructural LID techniques of preservation of natural areas and features and clustering of buildings and infrastructure. These techniques can significantly reduce the stormwater impacts of development. Naturally vegetated areas reduce runoff volumes and peaks through infiltration and groundwater recharge, surface storage, and evapotranspiration. The plants and soils also act to filter nutrients and pollutants that would otherwise flow through stormdrains and directly into natural waterways. Clustering buildings allows for maximum preservation of natural areas, a reduction in infrastructure, and the minimization of impervious area.

Cluster Buildings and Uses

Clustering of buildings and uses allows the same square footage to be achieved on a site while reducing site coverage and disturbance. Clustering also achieves a reduction in infrastructure, reducing impervious surface area.

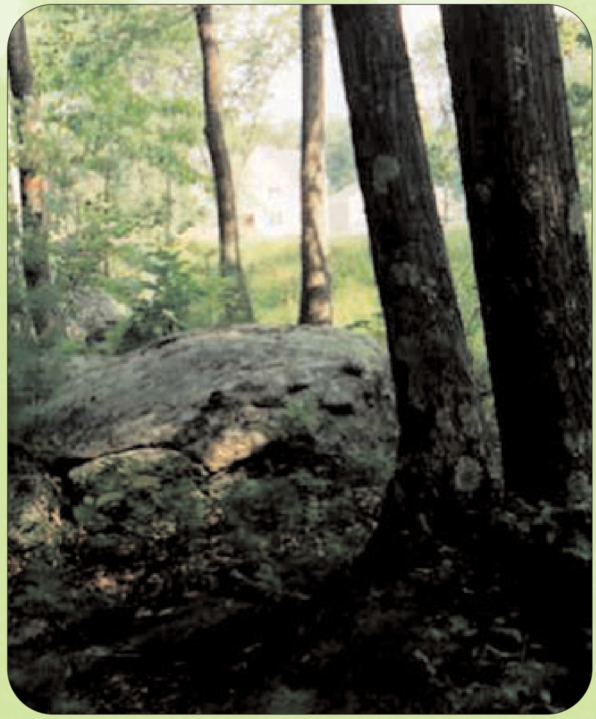
Fit the Development to the Terrain

Roadways should be laid out after approximate building and lot locations are determined. Road patterns should match the landform. For example, in rolling terrain, local streets should branch from collector streets, ending in short loops or cul-de-sacs along ridgelines. In areas where the topography is characteristically flat, the use of grids may be more appropriate. In these schemes, natural drainageways are preserved by interrupting and bending the road grid around them. Grassed waterways, vegetated drainage channels, or water quality

In Colby Village, Newburyport, houses are clustered closer together than in traditional subdivisions. This reduces the impervious surface area and allows for more open space to be preserved.

swales may then be constructed along street right-of-ways or on the back of lots to channel runoff without abrupt changes in the direction of flow.

Steep slopes should be considered environmentally sensitive areas and should be disturbed as little as possible. Steep slopes have significant potential for erosion when disturbed, increasing sediment loading to water resources. Creation of slopes steeper than 2:1 should also be avoided unless stringent stabilization methods are used.



Native vegetation—such as this forest—acts as a natural buffer to filter stormwater. By preserving this vegetation, runoff is reduced and residents enjoy natural views.

Maintain as Much of the Pre-Development Vegetation as Possible

Natural vegetation should be preserved as much as possible. Particular attention should be paid to protecting larger trees and areas of native vegetation that act as buffers between new structures and environmentally sensitive areas. Vegetation acts as a filter and absorbs water, which will reduce the amount of stormwater runoff. Proposed structures should be sited to minimize shading effects on vegetation, and roots should be protected from damage during the construction phase. Where existing vegetation cannot be preserved, opportunities to revegetate, especially to reforest, should be explored. Lawns and turf are not an adequate substitute for meadows and woods.

Plan Construction Activities to Minimize Disturbance and Soil Compaction

The manner in which construction activities are conducted can have a substantial impact on the hydrological functioning of a site once construction is complete. Even on sites where buildings are clustered, construction vehicles will often extensively clear vegetation, damage the roots of trees that are in undisturbed areas, and compact the soils so that natural infiltration capacity is reduced. This impact can be minimized by clearly defining a construction disturbance envelope, and by delineating construction vehicle pathways, preferably on existing impermeable soils or areas where impervious surfaces will be placed.

Place Buildings on Impermeable Soils, Minimize Placement of New Structures or Roads over Permeable or Erodible Soils

The process of infiltration and adsorption of stormwater through permeable soils is the best and cheapest mechanism for reduction of runoff volume and peak discharge, recharge of ground water supplies, and treatment and filtering of pollutants. Placing buildings on areas of the site with less permeable soils reserves porous areas for stormwater infiltration and BMP placement. In addition, disturbance of unstable soils should be avoided due to their greater erosion potential.

2. Maintenance and Utilization of Natural Drainage Systems, Elimination of Curb and Gutter Systems

Natural depressions and channels act to slow and store water, promote sheet flow and infiltration, and filter pollutants. The standard approach of using curbing on streets and parking areas, however, impairs natural drainage systems. Streets with curbs and gutters trap runoff in the roadbed and divert the stormwater to storm inlets and drains. The storm drain pipes are usually located in the valleys and low areas, destroying natural drainageways and losing natural filtration and infiltration capacities in the most strategic locations.

Natural drainageways are consequently converted from slow moving, permeable, absorptive, vegetated waterways to fast moving, impervious, self cleaning, paved waterways. The net effect of a seemingly beneficial decision to use curbs can initiate a snowball effect that amplifies the extremes in the hydrologic cycle, increasing flood flows and reducing base flows.

If naturally vegetated drainageways are preserved, flood volumes, peak discharges, and base flow will be maintained at pre-development levels. In addition, as the runoff percolates through the subsurface soils, trace metals, hydrocarbons, nutrients, and other pollutants will bind to the underlying soils and organic matter, filtering the stormwater that ultimately flows to waterways.

3. Disconnection of Impervious Surfaces

The adverse impact of impervious surfaces can be mitigated by designing them so that they are not directly connected to a site's drainage system. When impervious surfaces are "disconnected," runoff is allowed to sheet flow from the impervious area across a downstream pervious surface, where it has the opportunity to re-infiltrate into the soil, reducing the total runoff volume. These areas should be designed so that the shape, slope, and vegetated cover in the downstream area is sufficient to maintain the flow as sheet flow and that the discharge not erode the downstream area.

Particularly good opportunities for disconnection of impervious surfaces include roof runoff, patios and driveways, and sidewalks. For example, roof runoff can be converted to sheet flow using downspouts equipped with splash pads, level spreaders, or dispersion trenches to reduce flow velocity and disperse the flow. Sheet flow from driveways, patio areas, and sidewalks can be directed toward vegetated buffers.

4. Minimization of Impervious Surfaces

Cluster Lots and Buildings

Clustering not only allows preservation of natural areas (see 1, above), but also reduces the overall roadway and infrastructure length, reducing the amount of impervious area added to a site.

Reduce the Horizontal Footprint of Buildings and Parking Areas

Footprint size can be reduced by constructing a taller building or including parking facilities within the building itself, while maintaining the same floor to area (FAR) ratio.

Reduce Roadway Width and Length

Road widths can be reduced to the minimum required for traffic considerations and emergency vehicle access. (The national standard is 18 feet.) Road widths specified in traditional subdivision regulations are often far larger than necessary and may be modified by waivers. Cul-de-sacs may similarly be reduced in size, although in some cases this will require modifications of frontage requirements. As an alternative, vegetated islands in cul-de-sacs reduce overall impervious surfaces and can be designed to receive stormwater runoff from the surrounding pavement.

Subdivisions with shorter, or shared, driveways and narrower road widths have a lot less impervious surface area, which means less stormwater runoff and less infrastructure maintenance.

On-street parking lanes can be reduced to one lane, or eliminated if practical, on local access roads.

Roadway lengths can be reduced by clustering buildings and designing with the landform. (See I above.)

Reduce Driveway Length and Width

Driveways should be no larger than required for property access. The use of shared driveways can also be a consideration.

Eliminate or Limit Sidewalks to One Side on Local Low Traffic Roads

The area of impervious sidewalk should be no larger than necessary. Permeable surfacing (see right) can provide a good alternative to impervious sidewalks.

Permeable surfaces, like this sidewalk, are attractive and help to hold and infiltrate stormwater, reducing the amount of runoff that needs to be treated.

Local regulations as obstacles to LID

In some communities, local bylaws prohibit or limit clustering, road width reductions, and other LID techniques that reduce development's impact. Ironically, this may be the case even in communities that have adopted a LID bylaw, or if zoning or subdivision control and wetland regulations have not been updated to be consistent with LID practices. In communities where zonings permits some form of clustering, regulations should be amended to maximize the natural area to be preserved. Communities should consider the benefits of clustering and other LID techniques for open space preservation, stormwater control, and water quality when reviewing their ordinances and regulations.

Reduce Frontage and Other Setbacks that Result in Increased Paved Areas

Frontage requirements translate directly into longer roadway lengths, which in many cases are longer than would be necessary with more flexible frontage requirement. Communities should consider reducing frontage requirements, without increasing density, to reduce the required paved area.

Other setbacks may also contribute to impervious surface area. Street setbacks may result in longer driveways. Side setbacks may constrain use of shared driveways.

Use Permeable Surfacing Materials

Use "turf pavers," gravel, porous pavement, or other permeable surfaces when possible for sidewalks, driveways, transition areas between pavement edge and swales, or overflow parking areas.

5. Planning for Effective BMP Placement

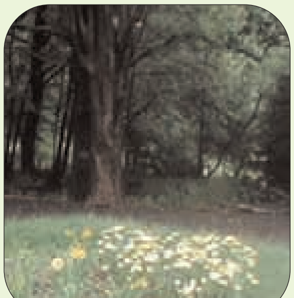
Low Impact Development also mandates that structural BMPs required for treatment be sited as close to the source as possible. This means use of numerous smaller BMPs, such as bioretention areas and dry wells. Consideration of the need for these features during the site design process will permit placement of the structures in the most suitable location, depending on the permeability of soils, slope of the site, and other factors.

Selection and Placement of Structural LID BMPs

The final stage of LID site planning is the selection and placement of structural BMPs to address any remaining stormwater impacts. This stage will be the most familiar to conventional practitioners, who are accustomed to addressing stormwater management concerns once the site design is nearly complete. The LID difference, however, is that the entire process of LID site planning is a preventative stormwater strategy, so that the need for structural stormwater controls is vastly reduced. Furthermore, selection of structural LID-BMPs differs in both the type of BMPs involved and their placement.

Placement of structural LID-BMPs is governed by the maxim to manage stormwater as close to the source as possible. Numerous small infiltration devices, rain gardens, swales, and other BMPs may be used on individual lots or within town easements. The BMPs that are applied in LID developments are those that mimic the response of undeveloped areas to precipitation. They include:

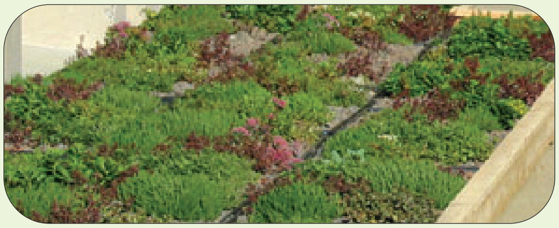
* **Bioretention areas/rain gardens:** A bioretention system (also referred to as a "rain garden" or a "biofilter") manages and treats stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. The method combines physical filtering and adsorption with bio-geochemical processes to remove pollutants. See *LID Case Study: Cohasset* for an example of a successful townwide retrofit of a stormwater drainage system with bioretention cells.



Pretty and practical: A rain garden in Cohasset naturally filters storm water.

* **Infiltration structures:** Infiltration structures include dry wells, infiltration trenches, infiltration basins, and similar devices and generally consist of an excavation back filled with a porous material, such as crushed stone or gravel. These structures store water in the void space between the porous material and the water slowly percolates downward into the subsoil. Infiltration structures can be used for clean runoff (such as roof runoff) or may be combined with pretreatment for more general use.

* **Green roofs:** A green roof is a low-maintenance vegetated roof system that stores rainwater in a lightweight engineered soil medium, where the water is taken up by plants and transpired into the air. As a result, much less water runs off the roof, as compared to conventional rooftops. See *LID Case Study: Boston* for an example of an effective local green roof.



Sedums atop Boston's City Hall help to store rainwater.

* **Water quality swales:** Vegetated swales are used to convey stormwater runoff, but unlike standard drainage channels, they are designed to improve stormwater quality. These open, shallow channels slow runoff, filter it, and promote infiltration into the ground; as a result, runoff volumes are smaller, peak discharge rates are lower, and runoff is cleaner.

* **Grass filter strips:** Grass filter strips are low-angle vegetated slopes designed to treat sheet flow runoff from adjacent impervious areas. Filter strips (also known as vegetated filter strips and grassed filters) function by slowing runoff velocities, filtering out sediment and other pollutants, and providing some infiltration into underlying soils.

* **Rain barrels/cisterns:** Cisterns and rain barrels are simple techniques to store rooftop runoff for reuse for landscaping and other nonpotable uses. This technique is based on the LID approach that considers rooftop runoff as a resource that should be reused or infiltrated.

LID and State and Federal Stormwater Management Programs

In many cases, developments will be subject to the requirements of the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Policy and/or require a U.S. Environmental Protection Agency National Pollutant Discharge Elimination System (NPDES) Phase II permit for stormwater management. These programs are entirely consistent with an LID approach. The MassDEP technical handbook, for example, includes site design techniques and emphasizes that site design and other nonstructural approaches should be considered before selection of structural BMPs.

Further technical description of these techniques is available in the Massachusetts Department of Environmental Protection Stormwater Technical Handbook. *For more information:* http://www.mass.gov/dep/water/laws/swmpolv1.pdf.

Community Approaches to LID

Beyond site planning, LID also incorporates other techniques that prevent pollution by controlling the sources of pollutants in runoff. These can be applied on a site-by-site basis, but should also be considered as an aspect of a community-wide approach. These techniques include:

- Street and Parking Lot Sweeping
- Pollution Prevention Plans

- Catch Basin Cleaning
- Snow and Snowmelt Management
- Public Education (particularly on issues of pet waste management, lawn and garden activities, proper storage, use and disposal of household hazardous chemicals, and proper operation and maintenance of septic systems)

For more information: www.mass.gov/dep/water/laws/swmpolv2.pdf.

Resources

www.mass.gov/czm/smartgrowth/index.htm

www.mass.gov/envir/smart_growth_toolkit/index.html

www.epa.gov/owow/nps/lid/

www.lowimpactdevelopment.org/home.htm

www.nsrwa.org/greenscapes/

www.nsrwa.org/programs/low_impact_development.asp

www.mapc.org/lid.html

www.nahbrc.org/greenguidelines/community.html#downloads

www.toolbase.org/PDF/DesignGuides/Builder_LID.pdf

Production Notes

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