4.8 Subsurface Infiltration

Subsurface infiltration systems are designed to provide temporary below grade storage infiltration of stormwater as it infiltrates into the ground. Dry wells, infiltration trenches and beds are a few examples of these types of systems. Infiltration is a preferred method for stormwater management where appropriate site conditions and soils exist. The use of infiltration methods helps to minimize the stormwater loading on existing storm sewer systems and can reduce the amount of overflows for combined sewer systems. By infiltrating stormwater on-site, downstream impacts resulting from stormwater flows are reduced or in some cases eliminated.

SUBSURFACE INFILTRATION COLLECTING DRAINAGE FROM AN IMPERVIOUS AREA

Key elements:

- Infiltration testing is required for this Stormwater Management Practice.
- Reduce volume of runoff from a drainage area by promoting infiltration through uncompacted subgrade.
- Can be sited beneath lawns, parking areas, and recreational areas.
- Maintain minimum distance from building foundation (typically 10 feet down-gradient minimum).
- Storage is provided within voids of open-graded aggregate or other approved material. • System must be designed to drain down in less than 72 hours.
- Greater than 2 feet from any limiting zone such as groundwater or bedrock.
- Pre-treatment is required.
- Positive overflow required for large storms.
- Areas of soil contamination or areas of unstable soils should be avoided.

Table 4.8.1: Subsurface Infiltration Potential Application and Stormwater Regulation

Potential applications			Stormwater regulations		
				Infiltration	No Infiltration
Residential Subdivision:	Yes		Water Quality Benefit	Yes	Yes
Commercial:	Yes		Volume Reduction	Yes	No
Ultra Urban:	Yes		Attenuation Benefit	Yes	Yes
Industrial:	Yes				
Retrofit:	Yes				
Highway Road:	Yes				

Acceptable forms of pre-treatment

- Filter
- Bioretention
- Filter Strips
- Appropriate prefabricated and proprietary design
- Sumped inlets with traps

Subsurface Infiltration in the Urban Landscape

Subsurface infiltration systems are typically stone-filled beds or trenches beneath landscaped or paved surfaces. Stormwater flows into the subsurface infiltration system, collects within the aggregate void space, and slowly infiltrates into surrounding soils. Subsurface infiltration is a versatile management practice suitable for many different types of land uses. Both high-density development and individual residences can implement subsurface infiltration systems for stormwater control. Their flexibility also makes them an option for a stormwater retrofit. Several example uses for subsurface infiltration are provided below.

SUBSURFACE INFILTRATION INSTALLED AT A SCHOOL ATHLETIC FIELD

Parking Lots and Roadways

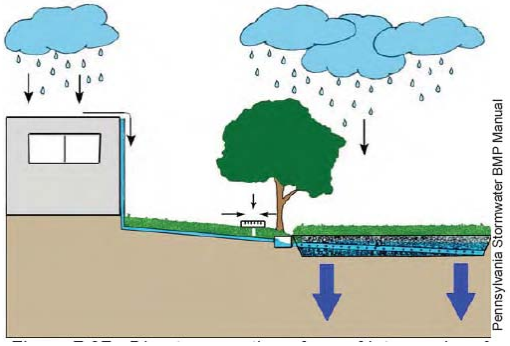
Stormwater inlets in parking lots or streets can be directly connected to subsurface infiltration systems. Sumped or trapped inlets prevent sediment and debris from migrating into the infiltration bed. The inlets can be connected to subsurface infiltration systems located underneath landscaped areas, recreation areas, or under the impervious surfaces themselves.

Lawns and Recreational Areas

Open green spaces can collect, store, and infiltrate runoff from impervious surfaces.

Direct Connection of Rooftops

Downspouts can be connected to subsurface infiltration beds at both residential and commercial sites. Small subsurface infiltration areas that manage roof runoff from residential roofs or that are distributed around a larger building to manage runoff from smaller sections of roof are often called dry wells. Although roofs do not often generate high sediment loads, sumped cleanouts should be located between the roof and the infiltration area. The roof leader connects to perforated piping when it reaches the subsurface infiltration area.

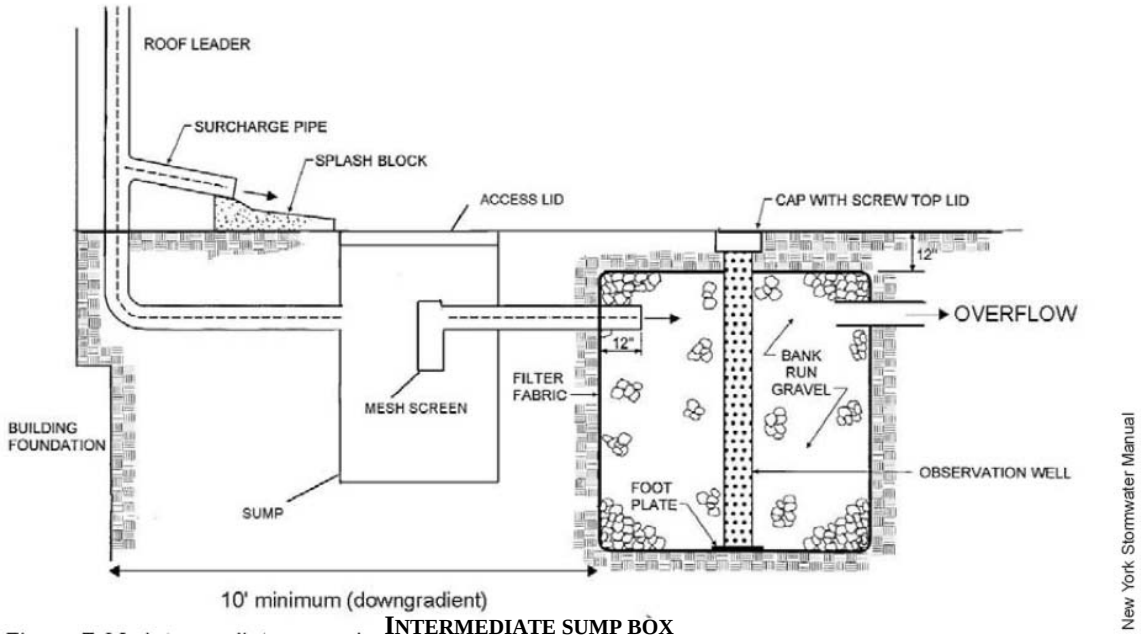


DIRECT CONNECTION OF A ROOF INTO A SUBSURFACE INFILTRATION BED

Components of a Subsurface Infiltration System

There are many variations of subsurface infiltration systems, but they are often comprised of these components:

- Inflow/Pretreatment
- Storage
- Observation well
- Infiltration/Outflow



INTERMEDIATE SUMP BOX AND DRY WELL

Inflow/Pretreatment

Subsurface infiltration systems are capable of intercepting stormwater inflow from many sources, including rooftops, parking lots, roads, sidewalks, and driveways. It is important to prevent coarse sediments and debris from entering subsurface infiltration systems, because they could contribute to clogging and failure of the system. The following are acceptable forms of pretreatment.

- Roof leader sump, or an intermediate sump box
- Roof gutter guard (may require additional sump unit depending on structure design).
- Filter Strips, see (See Section 4.4 Filter Strip Fact Sheet and the Stormwater Specifications Manual).
- Vegetated Swales, See (See Section 4.7 Swales Fact Sheet and the Stormwater Specifications Manual).

PREFABRICATED STORAGE

Storage

The storage component of a subsurface infiltration area is typically provided by a stone filled, level-bottomed bed or trench. The void spaces between the stones stores stormwater until it can percolate into surrounding soils. Alternative subsurface storage products may also be used to provide temporary storage. These include a variety of proprietary, interlocking plastic units with much greater storage capacity than stone fill (up to 96% void space). Perforated pipe in a stone bed can also increase the effective void space of the system. The higher void ratio of underground storage units requires a smaller footprint and can allow more flexibility in an urban environment, but proper analysis should be completed to ensure that the in-situ soils will adequately drain with the additional loading and that loading ratio and effective head maximums are not exceeded.

Observation Well

An observation well should be located at the center of the trench to monitor water drainage from the system. In a subsurface infiltration system, the water level is the primary means of measuring infiltration rates and drain-down times. A lockable above ground cap is recommended. Adequate inspection and maintenance access to the observation well should be provided. Observation wells not only provide necessary access to the system, but they also provide a means through which pumping of stored runoff can be accomplished in a failed system.

Infiltration/Outflow

Outflow occurs via infiltration through subsurface soil surrounding the infiltration storage area. A bypass system should be implemented for all infiltration systems to convey high flows around the system to downstream drainage systems. Depending on the level of stormwater management required at the site, overflows can connect to an approved discharge point or other stormwater management practices.

Recommended Design Procedure

- Determine actual site soil conditions using a registered geologist, soil scientist or engineer.
-
- Determine the Water Quality and Quantity requirements on the site. See (City of Indianapolis Stormwater Specifications Manual).
- Must be greater than 10 feet down-gradient and 100 feet up-gradient.
- Create a Conceptual Site Plan for the entire site and determine what portion of the sizing requirements subsurface infiltration will meet. See (See City of Indianapolis Stormwater Specifications Manual).
- Investigate the feasibility of infiltration in the area proposed for a subsurface infiltration system. Investigate the feasibility of infiltration in the area proposed for subsurface infiltration (hotspot investigation, infiltration test, and geotechnical analysis). Infiltration testing must be within 25 feet of the infiltration footprint.
- Create a conceptual design for the subsurface infiltration system.

Table 4.8.2: Starting Design Values for Subsurface Infiltration Areas and Depths	
Area (surface area and infiltration area)	Largest feasible in moderately sloped areas of the site (Minimum of 1 square foot of infiltration area for every 5 square feet of contributing DCIA recommended.)
Maximum Storage Depth	2 feet of effective head. (2 cubic feet of storage volume per square foot of infiltration area.)
Minimum distance above limiting zone	2 feet
Minimum/Maximum drain down time	24/72 hours

- Estimate the total storage volume and adjust area and/or depths as needed to provide required storage. Open-graded aggregate sub-base may be assumed to have 30 to 40% void space for storage.

- Using infiltration area and the saturated vertical infiltration rate of the native soil, estimate how long the surface ponding and soil storage will take to drain. The maximum drain down time for the entire storage volume is 72 hours, but the Engineer may choose a shorter time based on site conditions and Owner preference. If storage does not drain in the time allowed, adjust the depth and/or surface area. Adjust the design until the volume and drainage time constraints are met.

- Design a positive overflow or bypass system for larger design storms. All systems must design overflow structures and pipes to convey at least the 10-year storm.

- Include acceptable form(s) of pretreatment into design.

- Observation well to be designed with a minimum 4 inch diameter perforated plastic pipe, and placed at the invert of infiltration bed with a lockable above-ground cap.

- Complete construction plans and specifications.

Materials

Storage Stone

- Stone used for subsurface storage shall be uniformly-graded, crushed, washed stone meeting the specifications of the City of Indianapolis.

- Stone shall be separated from soil by a non-woven geotextile filter fabric or a pea gravel filter.

Non-Woven Geotextile

- Geotextile shall consist of needled non-woven polypropylene fibers and meet the following properties:

    - Grab Tensile Strength (ASTM-D4632) $\geq$ 120 lbs
    - Mullen Burst Strength (ASTM-D3786) $\geq$ 225 psi
    - Flow Rate (ASTM-D4491) $\geq$ 95 gal/min/ft2
    - UV Resistance after 500 hrs (ASTM-D4355) $\geq$ 70%
    - Heat-set or heat-calendared fabrics are not permitted

Pipe

- Pipe used within the subsurface system shall be continuously perforated and have a smooth interior with a minimum inside diameter of 6-inches. High-density polyethylene (HDPE) pipe shall meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S.

- Any pipe materials outside the stormwater management practice are to meet City Plumbing Code Standards.

INSTALLATION OF A SUBSURFACE INFILTRATION TRENCH

Construction Guidelines

- Areas for proposed subsurface infiltration systems shall be clearly marked before any site work begins to avoid soil disturbance and compaction during construction. If areas are compacted during construction additional infiltration testing may be required.

- Provide erosion and sedimentation control protection on the site such that construction runoff is directed away from the proposed subsurface infiltration system.

- If the infiltration area is being used as a sediment basin during construction the bottom elevation of the sediment basin must be a minimum of 2 feet above the infiltration bed invert elevation.

- Complete site elevation grading and stabilize the soil disturbed within the limit of disturbance. Do not finalize the subsurface infiltration system's excavation and construction until the drainage area is fully stabilized.

- Excavate subsurface infiltration area to proposed invert depth and manually grade and scarify the existing soil surface. The bottom of the infiltration bed shall be at a level grade.

- Existing subgrade shall NOT be compacted or subject to excessive construction equipment prior to placement of geotextile and stone bed. If it is essential that equipment be used in the excavated area, all equipment must be approved by the Engineer. Use of equipment with narrow tracks or tires, rubber tires with large lugs, or high pressure tires will cause excessive compaction and shall not be used. Should the subgrade be compacted during construction additional testing of soil infiltration rates and system redesign may be required.

- Place geotextile and recharge bed aggregate immediately after approval of subgrade preparation to prevent accumulation of debris or sediment. Prevent runoff and sediment from entering the storage bed during the placement of the geotextile and aggregate bed.
- Place geotextile in accordance with manufacturer's standards and recommendations. Adjacent strips of filter fabric shall overlap a minimum of 16 inches. Fabric shall be secured at least 4 feet outside of bed.

- Install aggregate course in lifts of 6-8 inches. Lightly compact each layer with equipment, keeping equipment movement over storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings.

- Complete surface grading above subsurface infiltration system, using suitable equipment to avoid excess compaction.

Maintenance Guidelines

As with all infiltration practices, subsurface infiltration systems require regular and effective maintenance to ensure prolonged functioning. The following table describes minimum maintenance requirements for subsurface infiltration systems.

Table 4.8.3: Subsurface Infiltration Maintenance Guidelines

Activity	Schedule
• Regularly clean out gutters and catch basins to reduce sediment load to infiltration system. Clean intermediate sump boxes, replace filters, and otherwise clean pretreatment areas in directly connected systems.	As needed
• Inspect and clean as needed all components of and connections to subsurface infiltration systems. • Evaluate the drain-down time of the subsurface infiltration system to ensure the drain-down time of 24- 72 hours.	Biannually
Maintain records of all inspections and maintenance activity.	Ongoing

Note:
Design of subsurface infiltration systems are not limited to the examples shown within this text. Successful stormwater management plans will combine appropriate materials and designs specific to each site.