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M E M O R A N D U M

TO: Environmental Resource Permit Review and Compliance Staff
Environmental Resource Regulation Department

THROUGH: Tony Waterhouse, P.E.
Deputy Director, Environmental Resource Regulation Department

FROM: Damon Meiers, P.E.
Director, Stormwater Improvement Division

DATE: Date ?????????

SUBJECT: **Guidance Regarding the Use of Pervious Pavement Systems as Part of Environmental Resource Permit Applications**

The intent of this memorandum is to provide guidance for staff in reviewing Environmental Resource Permit (ERP) applications that include the proposed use of pervious pavement systems. In the past, the water quality or quantity performance of these systems has not been incorporated into the permit application calculations because there were not sufficient reasonable assurances to address issues pertaining to parent soil compaction, proper construction specifications and maintenance concerns. As a result their efficacy in Florida and the potential benefits were historically not well established. However, during the last few years, independent research and analysis of these systems has better quantified the ability of these systems to percolate stormwater and identified practices and specifications to address the previous concerns.

The use of pervious pavement systems is proposed to be a quantifiable component of the proposed Unified Statewide Stormwater Rule. This rule is anticipated to be in the rulemaking process until mid 2010 or later. Given recent research, sufficient information exists so that the water resource benefits of pervious pavement systems can currently be quantified and incorporated in the design of surface water management systems. This memorandum is designed to provide guidance on the current review of applications proposing the use of pervious pavement systems. This document is not to be considered a rule, and other alternative forms of reasonable assurances to those set forth below may be considered by the District.

Pervious pavement systems can include several types of materials or designed systems including but not limited to pervious concrete, pervious paver systems, modular paver systems and pervious aggregate/binder products. Several recent studies of these systems are available on the University of Central Florida (UCF) Stormwater Management Academy's website http://stormwater.ucf.edu/

Studies at the UCF Stormwater Management Academy have not provided sufficient reasonable assurances to justify the use in the permitting context of pervious asphalt and pervious pavements utilizing crushed & recycled glass. Therefore, based on current information pertaining to structural capability and hydraulic performance, the District does not anticipate that sufficient reasonable assurances exist to include these pavements in ERP calculations. These two systems may be allowed in the future pending improvements in their structural capability and hydraulic performance.

Pervious pavement systems may be proposed as part of a treatment train, with credit based on available storage volume, and the ability of the system to readily recover this storage volume. Pervious pavement design has two major components: structural and hydraulic. The pervious pavement system must be able to support the traffic loading while also (and equally important) functioning properly hydraulically. This document does NOT address the structural component of pervious pavement systems. ERP applicants should consult the product manufacture's pavement design standards to ensure that pervious pavements will be structurally stable, and not subject to premature structural failure.

Below are the types of practices, specifications, tools and potential conditions for review staff and applicants to consider for the use of pervious pavement systems. This is not intended to cover all potential designs. Professional judgment must be used in the review of proposed designs.

1. Location: Unless adequately addressed in the proposed design, pervious pavement systems should not be placed over poor draining soils (clay/hardpan, muck, etc.), in high traffic volume areas (public roadways), heavy wheel load areas, areas of frequent turning movements regardless of wheel loads (public roadways, drive thru lanes, around gas pumps, adjacent to dumpster pads, driveway entrances, etc.), or areas with high potential for hazardous material spills (auto maintenance, auto parts stores, chemical plants, etc.). Signage in pervious pavement areas should be posted to inform users with heavy wheel loads not to enter. If heavy wheel loads or other non-recommended conditions are proposed, then alternate methods of pavement design must be utilized (i.e. imported (hydraulically clean) fill, structural/permeable geo-fabrics, thicker pervious pavement sections, etc. above the parent soil). Pervious paver systems may have more ability to handle areas of frequent turning movements than other systems and should be considered depending upon the proposed use. The locations of pervious pavement systems should be clearly identified on the proposed construction plans and the acreage of pervious pavement should be identified in the staff report.

2. It is recommended that the Seasonal High Groundwater Table (SHGWT) elevation be greater than 24 inches below the bottom of the pervious pavement system in order to receive storm water quantity credit [i.e. lower NRCS Curve Numbers or Rational Method "C" values and (if applicable) any Required Attenuation Volume (RAV)]. The "system" is defined as the pervious pavement itself, the underlying storage reservoir, if utilized (i.e. pea rock, #57 stone, etc.), and the geo-fabric that wraps the underlying storage reservoir. For storm water quality storage credit [the Required Treatment Volume (RTV)], the SHGWT should be greater than 12 inches below the bottom of the pervious pavement system (refer to Figures 1, 2 and 3 for additional information).

   It is not expected that reasonable assurances can be provided to allow storage credit in sub-grade soil void spaces due to the uncertainty of sub-grade soil compaction, estimated depths to the

SHGWT and confining units (i.e. clay/hardpan), and the potential for “back to back” storm events (AMC 3 conditions).

3. A recovery/mounding analysis of the RTV/RAV should be submitted to provide reasonable assurances during review of the ERP application. Potential models can include: Modret©, PONDS©, ICPR Pond Pack© or equivalent software. Pre-construction soil testing should be submitted to the District at soil depths representative of the proposed system to obtain the necessary input parameters for the recovery/mounding analysis (depth to the SHGWT, depth to the confining unit and the vertical & horizontal hydraulic conductivity rates). The RTV should be recovered to the bottom of the pervious pavement system within 72 hours with a safety factor of two (2.0).

   For pervious pavement systems that provide additional storage in the underlying stone reservoir for flood control, one half (1/2) of the Required Attenuation Volume (RAV) should be recovered within 24 hours with a safety factor of two (2). As noted above, a recovery/mounding analysis should be utilized to demonstrate this recovery. Two possible ways to apply the safety factor are:

   (a) Reducing the design saturated hydraulic conductivity rates by half; or

   (b) Designing for the required RTV or RAV drawdown to occur within half of the required drawdown time.

   The safety factor of two (2.0) is based on the high probability of:

   - Soil compaction during clearing and grubbing operations,
   - Improper construction techniques that result in additional soil compaction under the retention BMP,
   - Inadequate long term maintenance of the retention BMP, and
   - Geologic variations and uncertainties in obtaining the soil test parameters for the recovery / mounding analysis (noted in subsequent sections below). These variations and uncertainties are especially suspect for larger retention BMPs.

   It is recommended that only the sustainable void spaces should be utilized for all RTV and RAV storage computations (including the stage/storage input for the mounding analysis). This information can be found on the Graphical Results tab of the *Pervious Pavement “Design Aid”* (in Excel® format), available at: **http://stormwater.ucf.edu/**

4. The applicant should provide reasonable assurances that the pervious pavement construction will be performed by a contractor certified by the product manufacturer to install the proposed pervious pavement system. A **Special Condition** should be added to the permit that requires the applicant to supply documentation of appropriate certification and conduct a pre-construction meeting with the District’s compliance staff.

5. Suggested soil compaction: parent soil maximum compaction of 92% - 95% Modified Proctor density (ASTM D-1557) to a minimum depth of 24 inches. Redevelopment projects where the

existing pavement section is to be removed; the compacted base should be removed and underlying soils should be scarified to a minimum 16 inch depth, re-graded, filled with hydraulically clean soils (if applicable), and proof rolled to a maximum suggested compaction of 92% - 95% Modified Proctor density (ASTM D-1557).

6. Runoff from adjacent landscaped areas should NOT be directed onto pervious pavement system areas unless the applicant demonstrates that the offsite areas that drain onto the pervious pavement will not increase sediment, silt, sand, or organic debris that increases the potential for clogging the pervious pavement. The design should reduce the likelihood of silts and sands from plugging the pavement void spaces (see Figures 5 – 8).

7. Except for pervious walks and bike paths, it is anticipated that curbing will be utilized around the pervious pavement to impede horizontal movement (refer to Figures 1, 2 and 3 for additional information). The curb around the pervious pavement system should extend at least eight (8) inches below the bottom of the pervious pavement material.

8. Except for pervious walks and bike paths, the system should be designed to allow nuisance ponding as an indicator that the pervious pavement system has failed. The nuisance ponding depth should be no more than two inches (see Figures 1 - 3). The permitted construction plans should delineate the areas that may be subject to nuisance ponding.

9. Other than pedestrian walks and bike paths, the maximum recommended slope for pervious pavements is 1/8 inch per foot (1.04%), zero % slope is preferred.

10. It is recommended that the applicant design the system to have an overflow at the nuisance ponding elevation to the down-gradient treatment system or outfall (see Figures 1 – 3).

11. With the exception of pervious walks and bike paths, the installation of Embedded Ring Infiltrometer Kits (ERIKs) or equivalent is recommended (see Figure 4 and 9). A minimum of two (2) ERIKs or equivalent per acre of pervious pavement is suggested. The permitted construction plans should delineate the location of all proposed ERIKs. ERIKs are not recommended to be placed at remote locations where subsequent testing may produce erroneous conclusions regarding the hydraulic function of the pervious pavement system. **Special Conditions** should be added to the permit that requires installation of any proposed ERIKs or equivalent, documentation of construction, and post-construction testing should be submitted as part of the construction completion certification (test results should be provided in report form, certified by the appropriate Florida registered/licensed Professional). It is not anticipated that the construction completion certification will be accepted if the vertical hydraulic conductivity is less than 2.0 inches/hour in any of the proposed ERIKs. For additional information on this in-situ infiltration monitor (ERIK), refer to the UCF research paper *"Construction and Maintenance Assessment of Pervious Concrete Pavements,"* 2007 at http://stormwater.ucf.edu/research_publications.asp

12. Storage (S) within the pervious pavement system, reduced Curve Number (CN) and reduced Rational "C" values can be provided using the *Pervious Pavement "Design Aid"* (in Excel® format), available at: http://stormwater.ucf.edu/. If applicable, the credit can be applied to the different

design storm routing calculations (CN, Rational “C” or S improvement), and/or as water quality & quantity retention volumes for the contributing area of the pervious pavement system. The values used (curve number, Rational “C” or system storage) should be documented in the permit staff report.

13. Maintenance: Periodic vacuum sweeping is recommended. For areas that have a condition of regular wind transported soil (near sand dunes or other coastal areas) or other conditions where excessive soil or other material deposition occurs, vacuum sweeping should be utilized (generally twice a year in June and December). If Embedded Ring Infiltrometer Kit (ERIK) or equivalent tests indicate vertical hydraulic conductivity less than 2.0 inches/hour or when nuisance ponding occurs, vacuum sweeping should be conducted. A **Special Condition** should be added to the permit requiring the submittal of a remediation plan should the vacuum operations fail to improve the vertical hydraulic conductivity to a rate greater than 2.0 inches/hour or resolve the nuisance ponding. The remediation plan should be prepared and submitted to the District’s compliance staff for review and approval. Maintenance records should be retained by the permittee and made available to District staff upon request.

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FIGURE 1

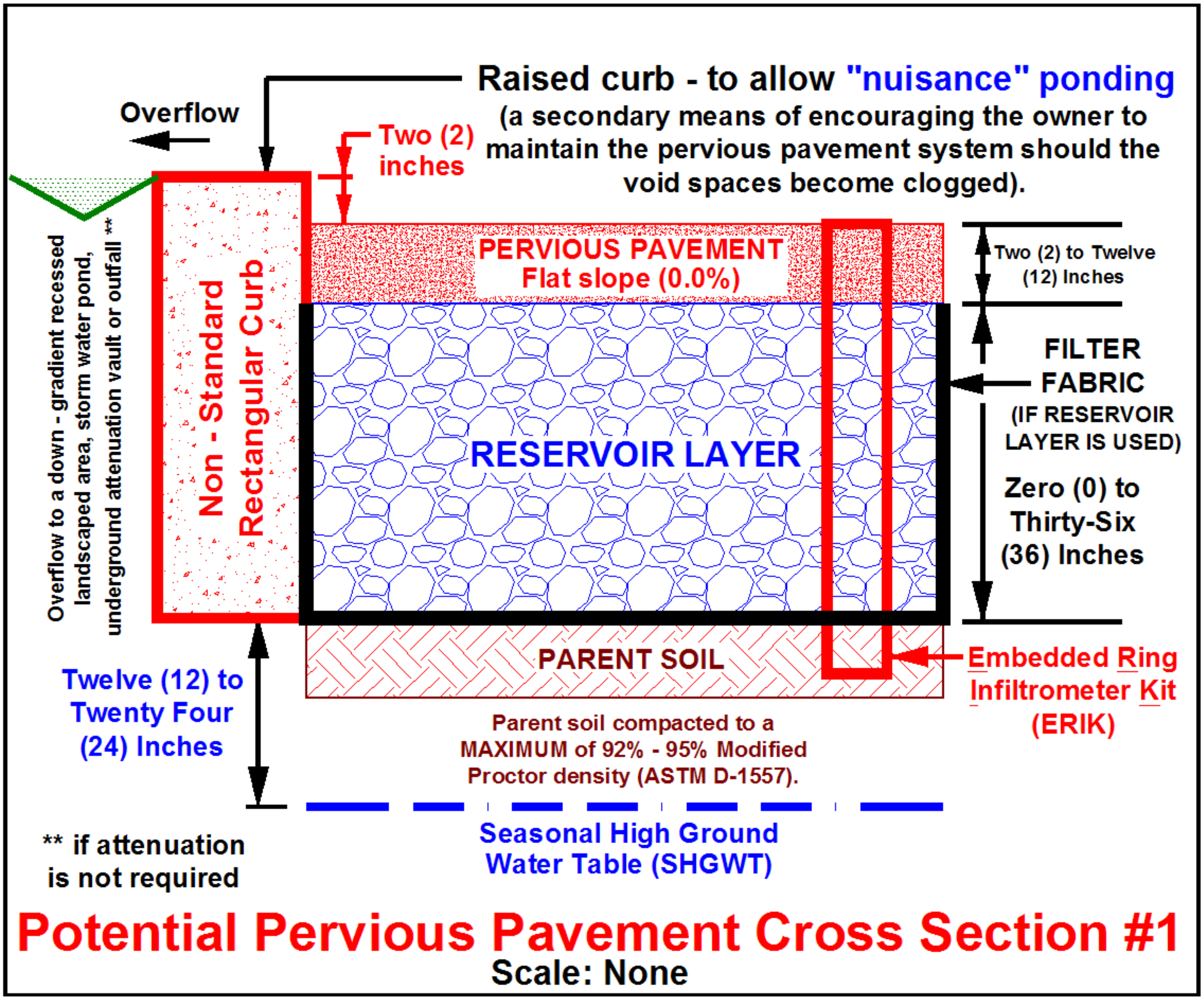

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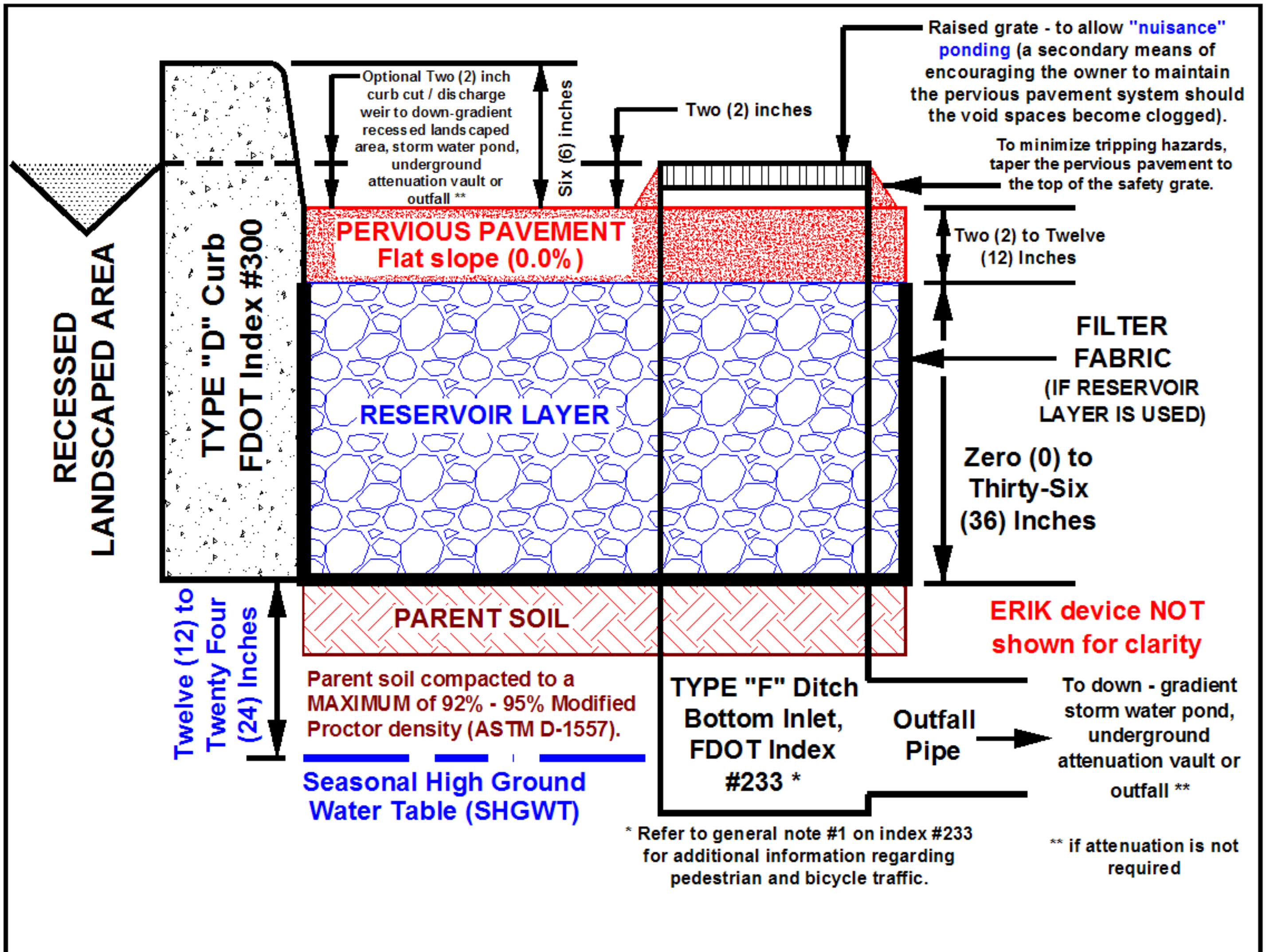
FIGURE 2



Potential Pervious Pavement Cross Section #2

Scale: None

In-situ infiltrometer NOT shown for clarity.

FDOT design standards (index drawings), available at:
http://www.dot.state.fl.us/rddesign/rd/RTDS/08/2008Standards.htm

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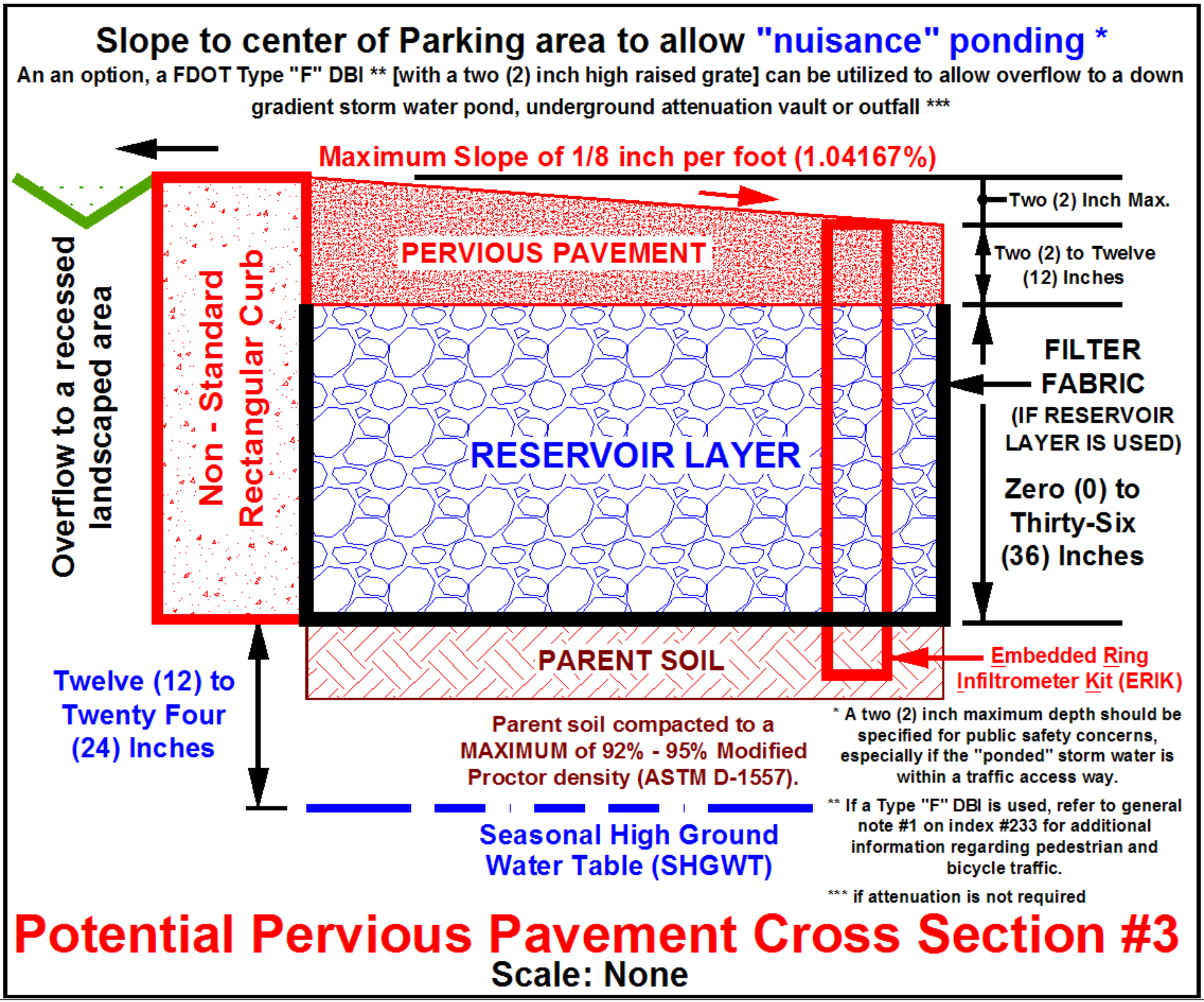
FIGURE 3



FDOT design standards (index drawings), available at:
http://www.dot.state.fl.us/rddesign/rd/RTDS/08/2008Standards.htm

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FIGURE 4

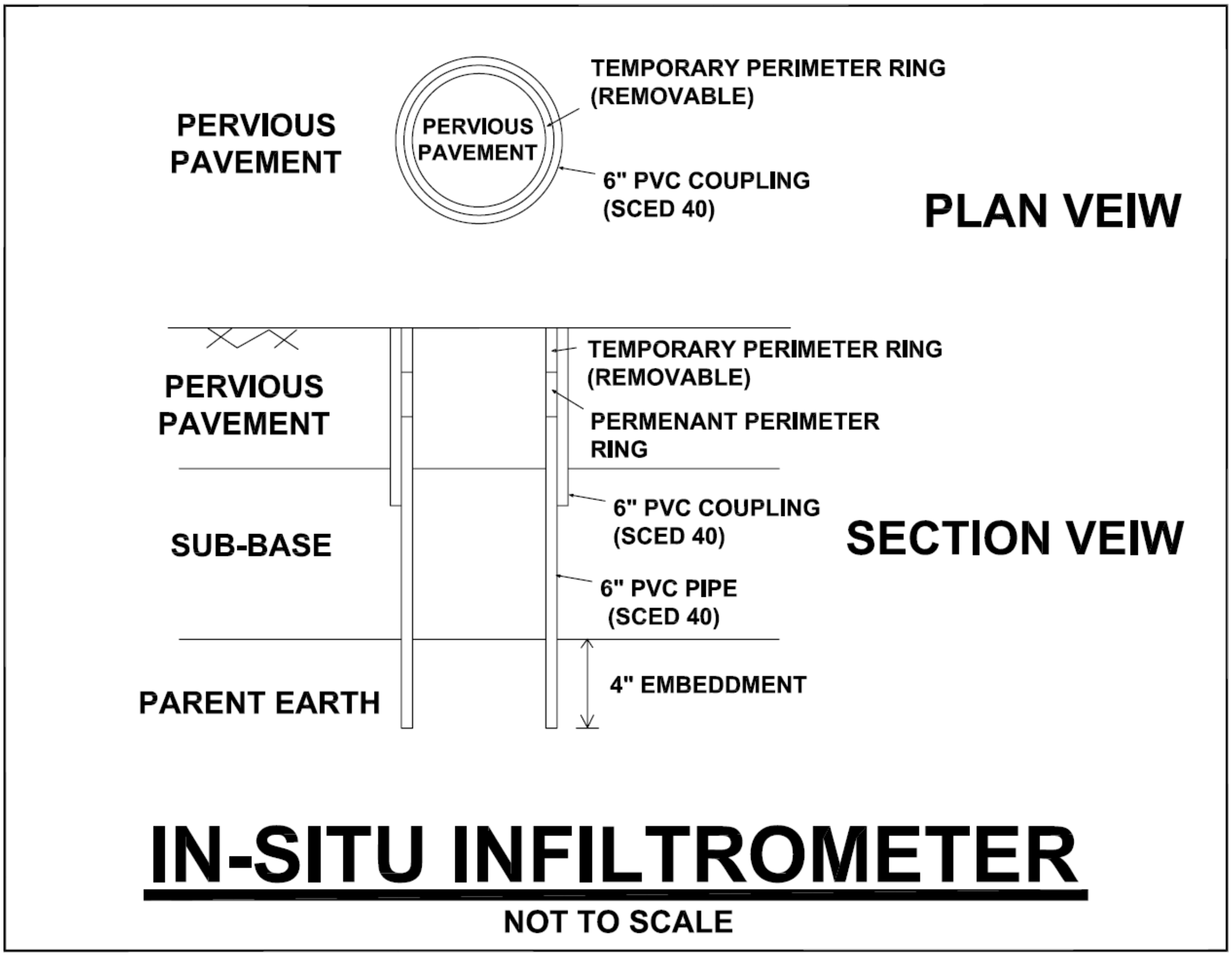

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FIGURE 5

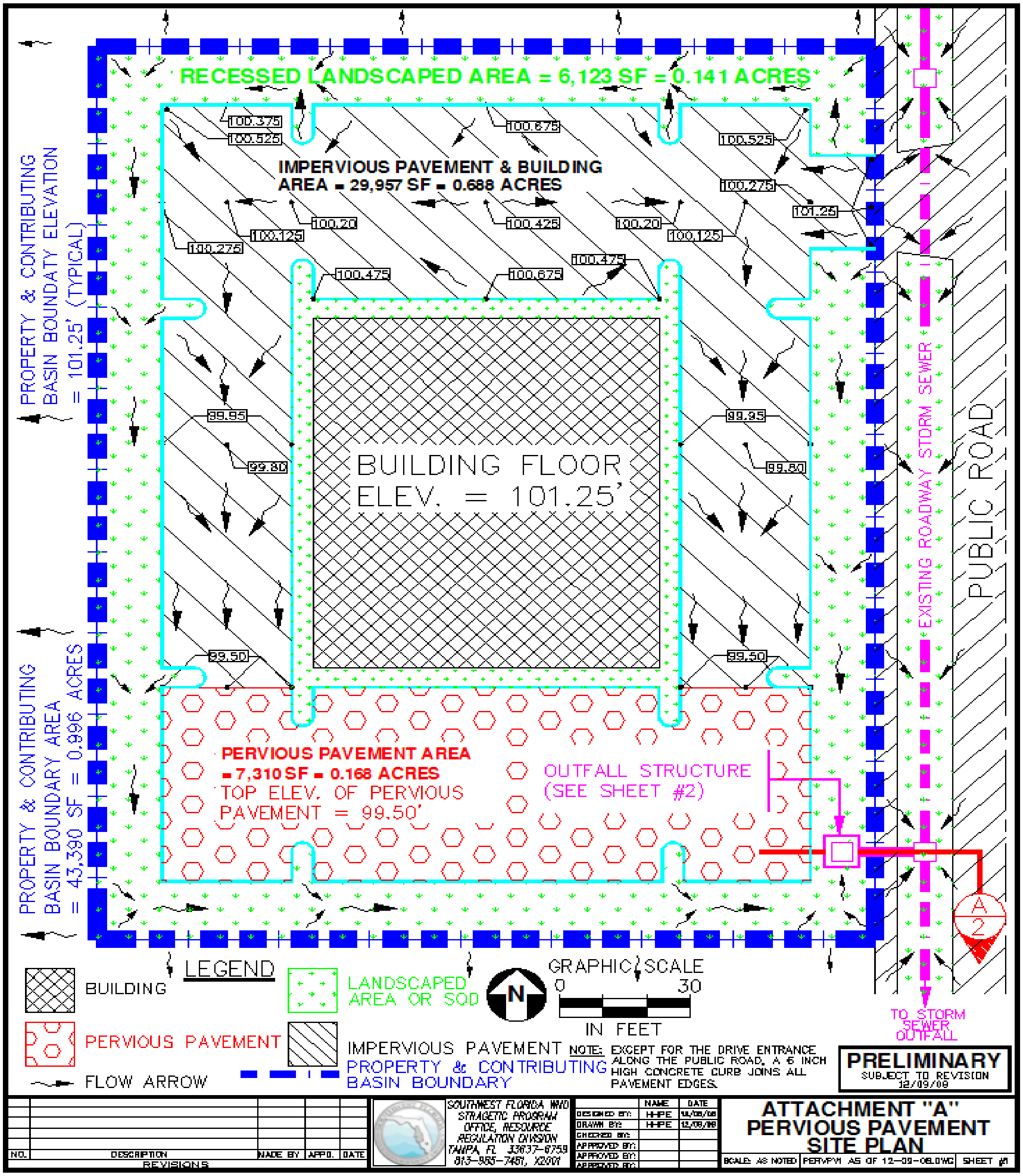

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FIGURE 6

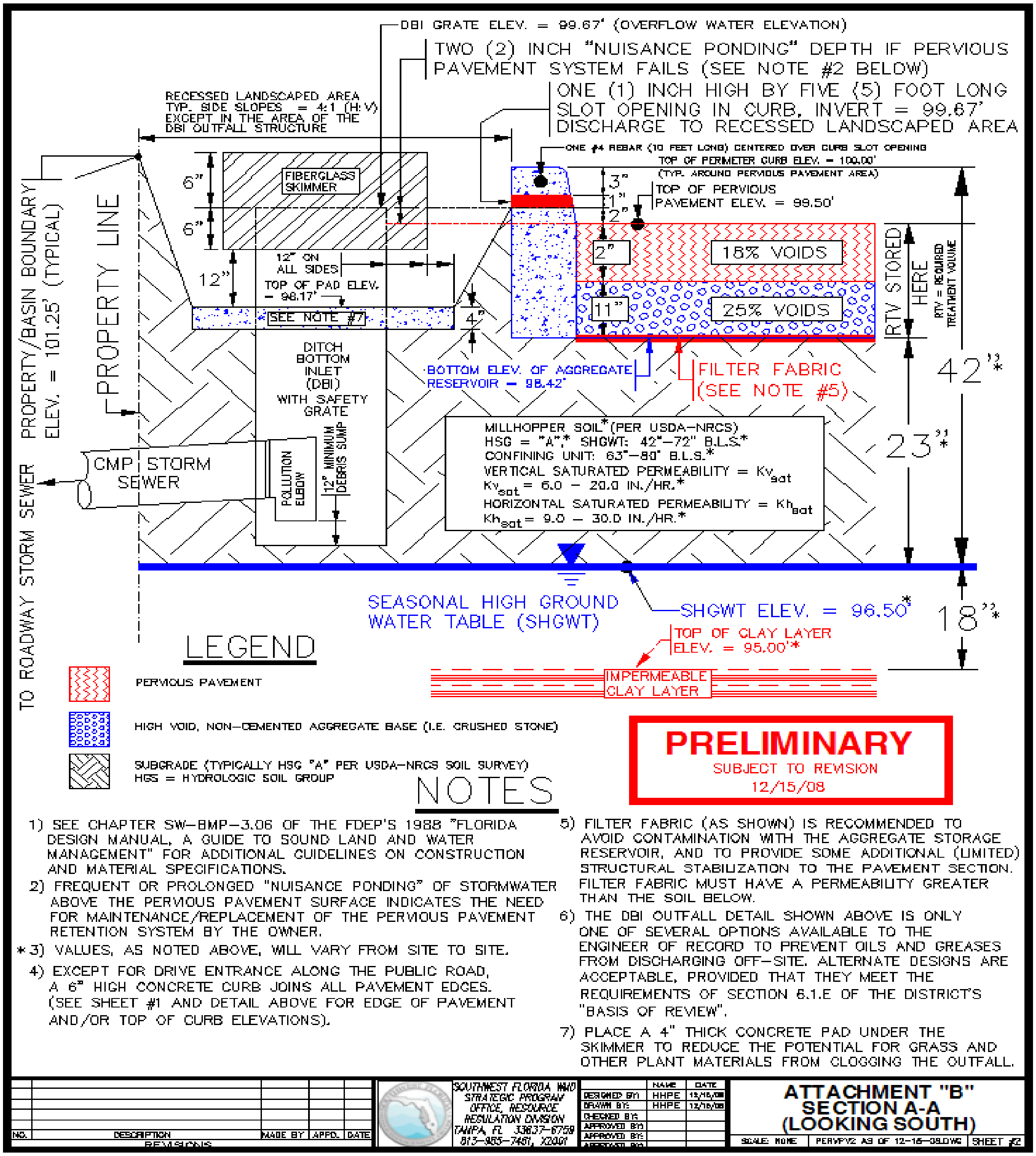

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FIGURE 7

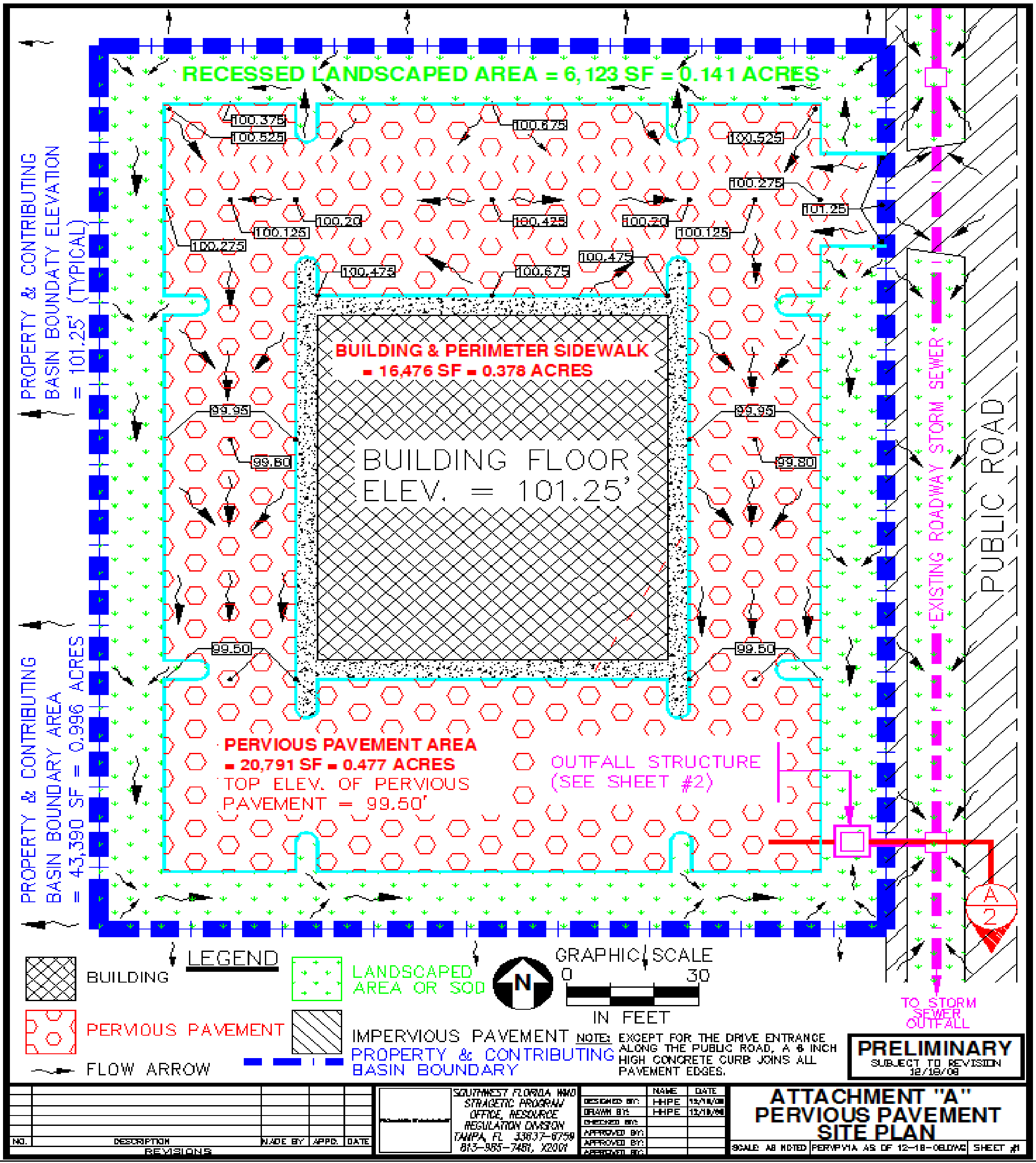

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FIGURE 8

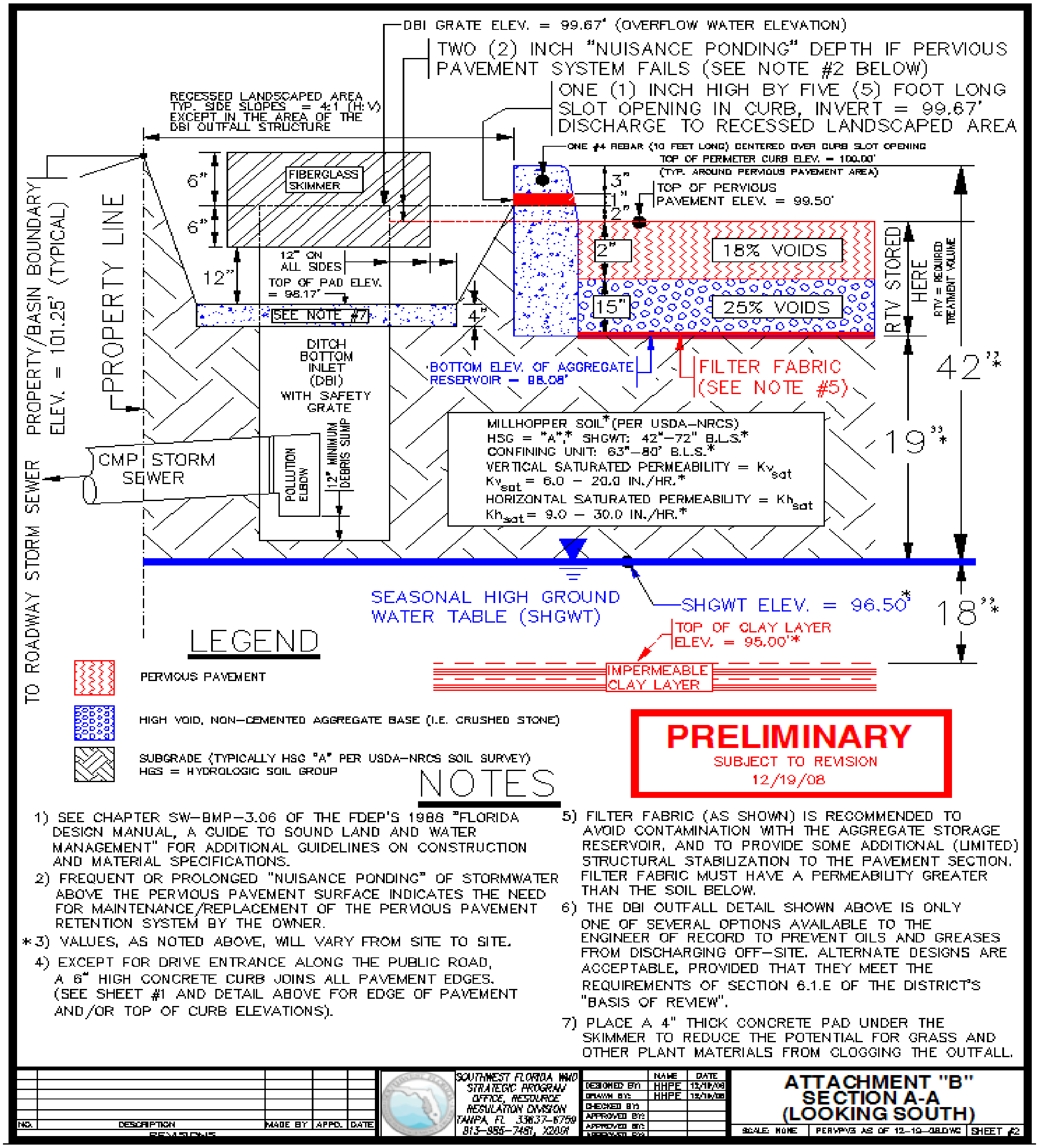

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FIGURE 9