FIELD APPLICATION OF A METHOD TO DETERMINE THE FEASIBILITY AND POTENTIAL BENEFITS OF IMPLEMENTING LOW IMPACT DEVELOPMENT TECHNIQUES AND RETROFITTING CONVENTIAL STORM WATER PRACTICES IN DEVELOPED AREAS

PART ONE: ANNE ARUNDEL COUNTY RESULTS

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1. INTRODUCTION

The Upper Patuxent River Watershed is located in western Anne Arundel County and northeastern Prince George's County. The main stem of the river forms the boundary between the counties of Anne Arundel and Prince George's. The watershed has a drainage area of 88 square miles, with 36 square miles in Anne Arundel County. In the State's 1998 Unified Watershed Assessment, the Upper Patuxent was listed as a Category 1 Priority Watershed when it failed two of the five water quality indicators. Watershed landscape indicators of water quality that had poor scores included percent of impervious surface, population density, soil erodibility, benthic index of biotic integrity, in-stream habitat and imperiled aquatics species indicator. All these watershed indicators can be directly correlated with urban and transportation corridor-related development.

To address the identified water quality issues, Anne Arundel and Prince George's Counties developed a Watershed Restoration Action Strategy (WRAS) proposal for the Upper Patuxent River. One aspect of the WRAS involves the development of a plan to target areas for the development of potential storm water management sites. Implementation of the plan will help mitigate the effects of uncontrolled runoff to the Patuxent River through the use of innovative and environmentally-sensitive development techniques and state-of-the-art storm water management practices. Targeting of the mitigation efforts will be based on stream corridor, biological and water quality assessments. These assessments will help to identify stream reaches in need of physical rehabilitation and provide needed information to be used in the prioritization of stream rehabilitation projects.

Together, Anne Arundel and Prince George's Counties received a grant from the Maryland Department of Natural Resources (DNR) to develop a watershed plan for the Upper Patuxent River Watershed (HUC No. 02131104). The Dewberry & Davis LLC (Dewberry) role in this effort was to perform the following tasks: (1) development of a site evaluation procedure, (2) completion of the site evaluation, and (3) site ranking. This report was prepared to document and to summarize these efforts. The site rankings will help the County set funding priorities for future storm water management retrofits in the watershed. The work performed in the Anne Arundel County portion of the Upper Patuxent River watershed is summarized in this document. The results of the Prince George's County portion of the watershed are summarized in Part Two.

2. SITE SELECTION

Based upon an examination of digital land use data and aerial photography, candidate areas of developed land were initially identified as potential retrofit areas. From this initial assessment, approximately 30 potential evaluation sites in eight subwatersheds were identified for further field investigation. Most of these sites had residential land uses. Preliminary investigations (windshield surveys) were then performed at six of the sites. During this time, it was determined that most of these residential sites did not require retrofitting. Most were large lot (one to three acre) residential with many Low Impact Development (LID) practices in place (e.g., large buffers, open-section roadways, disconnected downspouts).

In addition to the residential sites, two primary LID focus areas of developed land located within the Upper Patuxent River were considered. One was located in the developed corridor along Maryland Route 198 (Laurel Area) and the other was located near Crofton at the intersection of Maryland Route 450 and Maryland Route 3 and along Route 450 east to Maryland Route 424 (Crofton Area). Within each priority area, a total of 62 potential parcels were identified using aerial photography. Seventeen sites were located in the Laurel Area and 35 potential parcels were identified in the Crofton area. It was expected that focusing on a single parcel would increase the homogeneity of features recorded on site evaluation forms. Homogeneous features on a parcel were needed to facilitate the ranking of sites. As an initial attempt at prioritization, the County placed all potential LID parcels into four priority groupings, which are defined as follows:

Priority 1. Parcels contained within subwatersheds that were included in the WRAS Current Conditions Assessment. These parcels boarder the stream valley and likely have direct discharge into the stream or discharge through a SWM facility.

Priority 2. Parcels partially contained within subwatersheds that were included in the WRAS Current Conditions Assessment. These parcels do not boarder the stream valley.

Priority 3. Parcels within the Upper Patuxent River watershed but that are outside the boundary of an assessed WRAS subwatershed.

Priority 4. Parcels that are partially outside the boundary of the Upper Patuxent River watershed.

The County identified 34 sites in the Crofton Area and 17 in the Laurel Area, which were placed into one of the four priority groupings. For the sites within the Crofton Area the priority distribution follows: 13 were Priority 1, 13 were Priority 2, six were Priority 3, and two were Priority 4. Of the 34 parcels in the Crofton Area, 24 parcels were located in a densely developed area near Maryland Route 450 and Maryland Route 3. Of these 24 Crofton Area parcels, nine were Priority 1, nine were Priority 2, and six were Priority 3. There were no Priority 3 parcels in Crofton. Using the prioritization scheme described above, all of the 17 sites in the Laurel Area were classified as Priority 3. Consequently, a decision was made to focus on this commercial site in the Crofton Area (LID Focus Area). Within the LID Focus Area, parcels had various levels of urban and suburban land uses and some already had storm water management (SWM) within their watersheds.

Dewberry conducted an initial site visit to evaluate each parcel in the LID Focus Area. Four of the Priority 1 parcels were considered unsuitable in that two were used as material stockpile areas, one was undeveloped and another was so recently developed that no parcel information was available. Following the inital site visit, 15 parcels were selected as potential retrofit sites. Of these 15 final sites, three were Priority 1, four were Priority 2, and eight were Priority 3. Because all of the 15 sites appear to drain to the Patuxent River by one outfall, the priority scheme described was not used to differentiate the final selected sites . The locations of the 15 sites are shown in Figure 1.

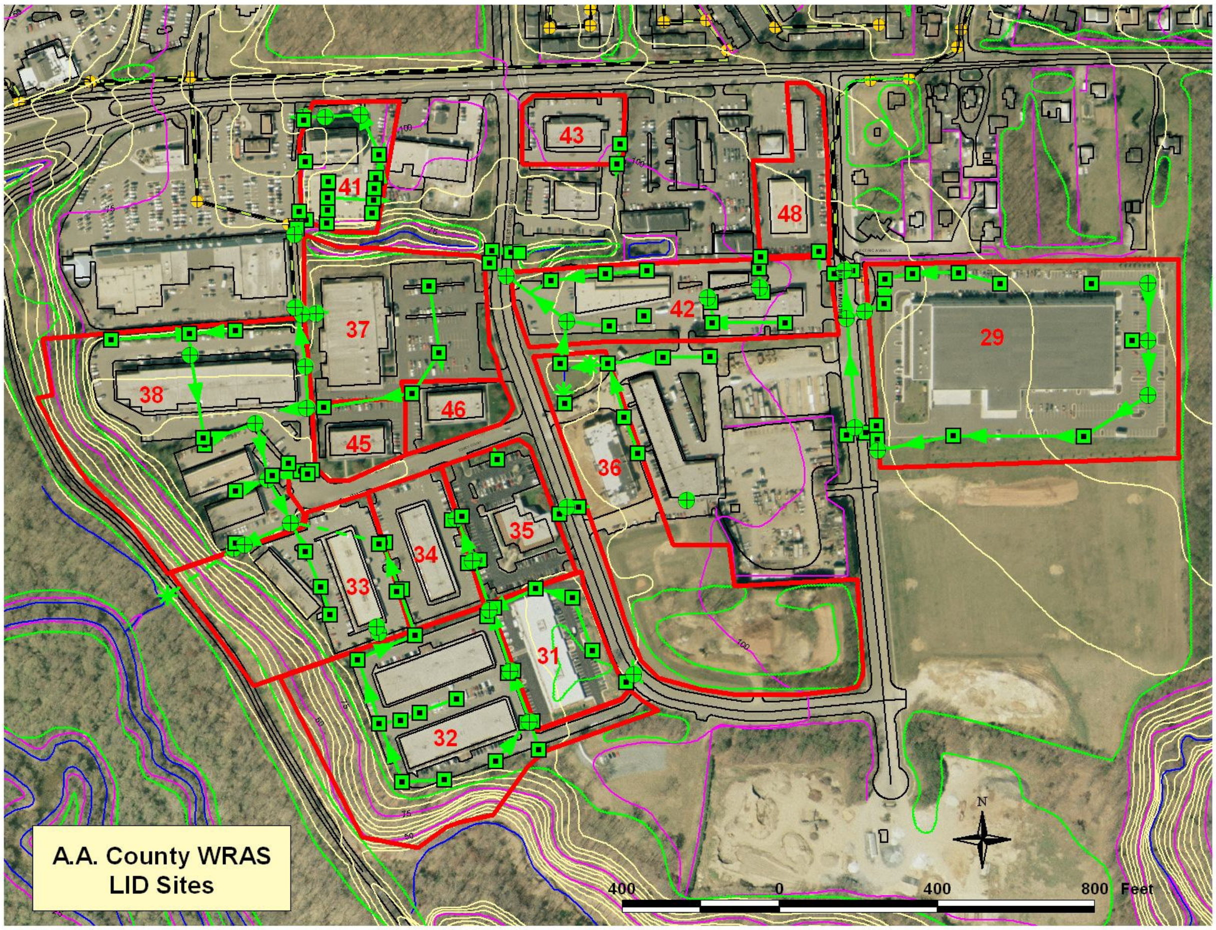

Figure 1. Location of the 15 Sites

3. SITE EVALUATION FORMS

Concurrent with the site selection process, a data needs and available information assessment was also completed. The assessment of the data needs and available information was needed to develop a procedure to evaluate the sites with the objective to rank the sites as to their potential for SWM retrofits. Data needs include mapping, impervious area, storm drain system layout, utilities, topography, parcel ownership, land use, and existing storm water management. Available information includes the County's GIS and soils information. The parcel evaluation procedure included the development of data collection forms. The data collection forms were structured to facilitate collection of information and to rank the sites.

Three forms were developed to facilitate collection of data and subsequent analysis.

Form 1 was used to record information concerning a catchment. As used here, a catchment is defined as a portion of the subwatershed. It was originally envisioned that a catchment would encompass an area of between 2 to 50 acres. However, as the assessments were initiated, the catchments were made smaller so that they were only as large as necessary to capture as much of the parcel area as possible. It is possible for one catchment to include one or more parcels. It is also possible that a catchment may not include the entire parcel area for a site, usually because of topography or the layout of the storm water drainage system. Form 1 is populated using existing information.

For each parcel, a catchment area was delineated. If possible, the outlet of the catchment was a defined storm water conveyance such as a channel, storm drain inlet or SWM facility. However, there were instances where no defined storm water conveyance was present, especially in flat areas or areas that border streams. If there was no defined storm water conveyance, it was necessary to use an arbitrary catchment outlet. As used here, a site is the portion of the parcel located within the catchment boundary. One catchment may also contain two or more sites. Conversely, one parcel may be contained within two or more catchments. In this instance, each portion of the parcel within a catchment is considered a unique site.

Form 2 is used to collect site information. Form 2 was populated mainly from site visits. Because storm drain information was unavailable, final catchment boundaries could not be determined until after the site visit. Therefore, Form 1 was not completed until after the site visit was conducted.

Form 3 was used to evaluate the opportunities and constraints of potential management practices for each site. All sites contained two or more proposed management practices. The relationship between the three data collection forms is presented in Figure 2.

Blank data collection forms are found in Appendix A. Guidance for the completion of the three data collection forms is presented in Appendix B. The guidance presented in Appendix B describes each data item.

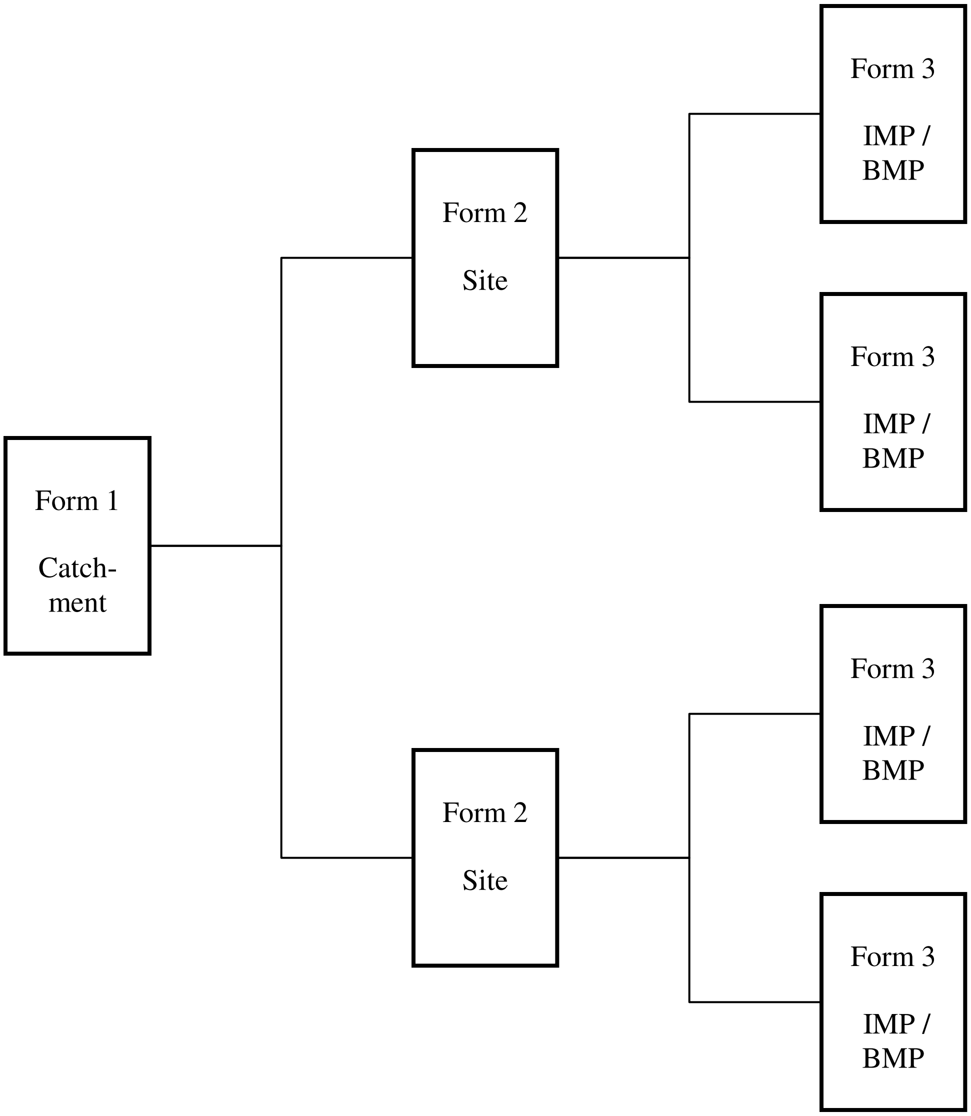

Figure 2. Relationship Between the Three Data Collection Forms

4. SITE EVALUATION

The initial step of the site evaluation was to prepare a map of the site using the County's GIS data. A copy of the map, which included an image from aerial photography was printed for use in the field. An approximate catchment boundary was also shown on the map. This catchment boundary was then revised based on observations made during the field visit. The County GIS did not show utility, storm drain or SWM information, which would have been used during a site visit.

The site maps were used during the field visit for reference and for annotation. The location of storm drain inlets were noted on the map. Connectivity of the storm drain system was investigated but could not always be determined. The location of existing SWM facilities were also noted on the map. Based on the topography and storm drain inlet information, the drainage boundary was recorded on the site map. The presence of utilities could be determined from meters, junction boxes, valve boxes, transformers, or manholes. In some instances, where there were recent construction projects in the area, the utilities were marked. If observed, the presence of utilities was noted. Photographs were taken to document the site and its characteristics. The portion of Form 2 requiring field data was completed. Form 2 is used to assess the site characteristics as they apply to suitability for potential SWM retrofits.

The opportunities and constraints for each site were assessed using Form 3. Focusing on the opportunities of the site, potential treatment for storm water was considered. Preferred potential treatment applications include Low Impact Development (LID) techniques called Integrated Management Practices (IMPs). Potential treatment applications also include SWM Best Management Practices (BMPs). Descriptions of the various IMPs / BMPs are found on Sheets 4 of 9 and 5 of 9 in Appendix B. In Appendix B, Sheets 6 of 9 and 7 of 9 identify the water quality impairments that are addressed for each IMP / BMP technique. The applicability of each IMP / BMP is identified on Sheets 8 of 9 and 9 of 9 in Appendix B.

Treatment was provided for as much of the site as possible, targeting impervious areas. Treatment applications that addressed water quality, quantity control and ground water recharge were given the highest priority. Treatment applications were evaluated on the basis of the benefit provided and constructability. Constructability includes constraints such as the presence of utilities, steep slopes, existing vegetation and mature trees; the suitability of soils and ground water table; and accessibility. Parking needs of the site were assessed when proposing a potential treatment application. In those areas where parking was in short supply or where truck access was required, parking and access were not altered.

In many situations, additional area could be treated by diverting flow. An inexpensive flow diversion is an asphalt "speed bump." If a "speed bump" would not be accepted by the site owner, a trench drain could be substituted.

After the site is assessed for the viability of treatment, specific practices are proposed. The approximate available footprint is noted on the site map. The drainage area to the treatment application is also drawn on the site map. Each treatment application is documented on Form 3. The documentation includes photographs of the proposed location.

Following the field assessment, the information from the forms is entered into the electronic version. Information recorded on the site map is entered into the County's GIS data base. The data collected in the field is used to complete the forms. The control provided by each treatment application is recorded on Form 3. The control provided by every treatment application within the site is summed and recorded on Form 2. Likewise, the control provided in each site within the catchment is summed and recorded on Form 1. All information is recorded electronically. The completed forms are found in Appendix D.

5. SITE RANKING

The completed forms are used to rank the sites. The purpose of the ranking is to identify the sites that would most benefit from the retrofit of treatment applications. Forty ranking parameters were identified and include the following:

- Impairment type
- Catchment water quality volume
- Predominant land use
- Sanitary sewer type
- Area served by storm drain system
- Percentage of channels that are not concrete
- Catchment existing storm water treatment
- Treatment provided for catchment
- Site percent impervious
- Site ground water recharge volume
- Site existing storm water treatment
- Treatment provided for site
- Pavement condition
- Roof connected directly to storm drain
- Existing drainage problems
- Existing landscaping
- Area available for above ground treatment
- Traffic islands
- Ground level of traffic island
- Trees have sufficient spacing for treatment
- Catchment percent impervious
- Catchment ground water recharge volume
- Depth to ground water
- Water supply type
- Percentage of drainage system that is piped
- Location of system in catchment
- Percent of catchment that is treated
- Site ownership
- Site water quality volume
- Site storm drainage type
- Percent of site that is treated
- Pavement type
- Underdrains could be installed
- Roof drains directly onto impervious area
- Steep slopes
- Mature / specimen trees
- Existing cover for potential sties
- Curb around traffic island
- Traffic island landscaping
- Area that can be directed to treatment

Each ranking parameter was given a score ranging from zero and one. The scoring range was developed so that a high score yielded a site that would most benefit from treatment retrofits or where retrofits would be relatively easy to implement. Three examples of the ranking system used in the Upper Patuxent River WRAS follow.

1. Existing Water Quality. A site with poor existing water quality would rank higher than a site with good water quality. Water quality was determined based on the Basin Condition Scoring (BCS) methodology developed for the Upper Patuxent River Watershed (Victoria, et al, 2003).
2. Existing Storm Water Management. Although storm water treatment is desirable from a water quality perspective, a site with existing storm water treatment would rank low. An attempt was made in the ranking procedure to address the type of facility and its overall condition. However, it is very likely that existing SWM would benefit from additional upstream treatment. Fish and macroinvertebrate studies including the one conducted by Prince George's County in Spring 2000, have shown that SWM ponds alone are not enough to protect physical habitat structure (cover, substrate, sedimentation) or hydrology (baseflow, thermal fluxes or flashiness). Therefore, the implication is that SWM ponds are limited in their ability to protect streams and cannot reproduce predevelopment hydrological functions.
3. Site Constraints. A site with adequate area to construct SWM would also rank high. Areas that are covered with grass would rank higher than area covered with pavement.

Conversely, a site that has a large portion that is covered with steep slopes or mature trees would rate lower. However, the grassed areas should still be treated with LID techniques. Several studies comparing grass / turf areas to meadow as shown significant difference in runoff and pollutant removal (meadow areas are more efficient and have less runoff).

The scoring for the ranking components developed for the Upper Patuxent River WRAS is presented on Sheet 2 of 2 in Appendix C.

The ranking parameters are not equally significant. To indicate the relative important of each ranking parameter, weighting factors were used. The less significant parameters were given a weight of less than one and significant parameters were given a weight greater than one. The derivation of the scores is presented on Sheet 1 of 2 in Appendix C. Sheet 1 of 2 provides the score for each of the 40 ranking parameters for each of the 15 sites.

It is anticipated that the ranking components, scoring and weighting will be adapted and refined with use and for use for other applications, depending on the goals of the project. Typically, an area with few site constraints would rank low. However, LID techniques are quite adaptable. For example, slopes that are conditioned and planted with native vegetation would decrease the amount of runoff. Bioretention benches could also be used on slopes.

One of the important tenets of LID is to subdivide larger sites into smaller drainage areas. By dividing sites into smaller drainage units, the number of LID practices that can be used is increased. There are many methods that can be used to subdivide larger drainage areas into micro drainage areas and employ LID techniques. For example, by using traffic calming devices (curb extensions, traffic humps, etc.) streets can be narrowed, divided into smaller drainage units and bioretention installed in the curb extensions and at storm drain inlets.

Also, the presence of mature vegetation at a site that is extensively landscaped was ranked low because the vegetation would need to be removed. In many cases, the landscaping consists of invasive plantings. Because invasive plants should be removed, LID practices could be installed without any adverse impact. Therefore, a new ranking factor needs to be developed. Training for site assessors to identify invasive species will be required.

The ranked sites are presented in Table 1. The top five sites have been bolded in Table 1. Although Site 42 was ranked #3, it was not identified as a viable site for retrofit. Site 42 ranked highly because of the large percentage of the site that is impervious, and the lack of landscaping and mature trees. However, the site appears to at an age and condition where it should be considered for redevelopment rather than retrofit with storm water management. Therefore, this site was removed from consideration.

The top five sites for storm water management retrofits are identified in Table 1. The top five sites in descending rank are 29, 31, 37, 35 and 45. None of these sites has any apparent existing storm water management. All of these sites have room for installation of storm water management retrofits and are highly visible to the public. The willingness of the parcel owners will determine which sites remain candidates for the installation of storm water management retrofits.

Table 1. Site Ranking Summary

Site Name	Site Description	Catchment	Subwatershed	Score	Rank
29	**Federal Express**	**UT01**	**Patuxent River**	**25.33**	**1**
31	**2141 Priest Bridge Road**	**UT04**	**Patuxent River**	**24.53**	**2**
42	Priest Bridge Buildings	UT11	Patuxent River	24.43	3
37	**Crofton Bowling Centre**	**UT02**	**Patuxent River**	**23.88**	**4**
35	**2127 Espey Court**	**UT08**	**Patuxent River**	**23.43**	**5**
45	**2128 Espey Court**	**UT02**	**Patuxent River**	**23.43**	**5**
38	2134, 2138, 2139 Espey Court	UT10	Patuxent River	23.08	7
46	2126 Espey Court	UT02	Patuxent River	23.03	8
33	2135 and 2137 Espey Court	UT06	Patuxent River	22.73	9
32	2145 and 2147 Priest Bridge Road	UT05	Patuxent River	22.38	10
34	2131 Espey Court	UT07	Patuxent River	21.78	11
48	2101 Defense Hwy & 2111 Baldwin Ave	UT13	Patuxent River	21.63	12
41	Priest Bridge Overlook	UT03	Patuxent River	21.08	13
36	2130 Priest Bridge Drive	UT09	Patuxent River	17.82	14
43	Priest Bridge Station	UT12	Patuxent River	17.48	15