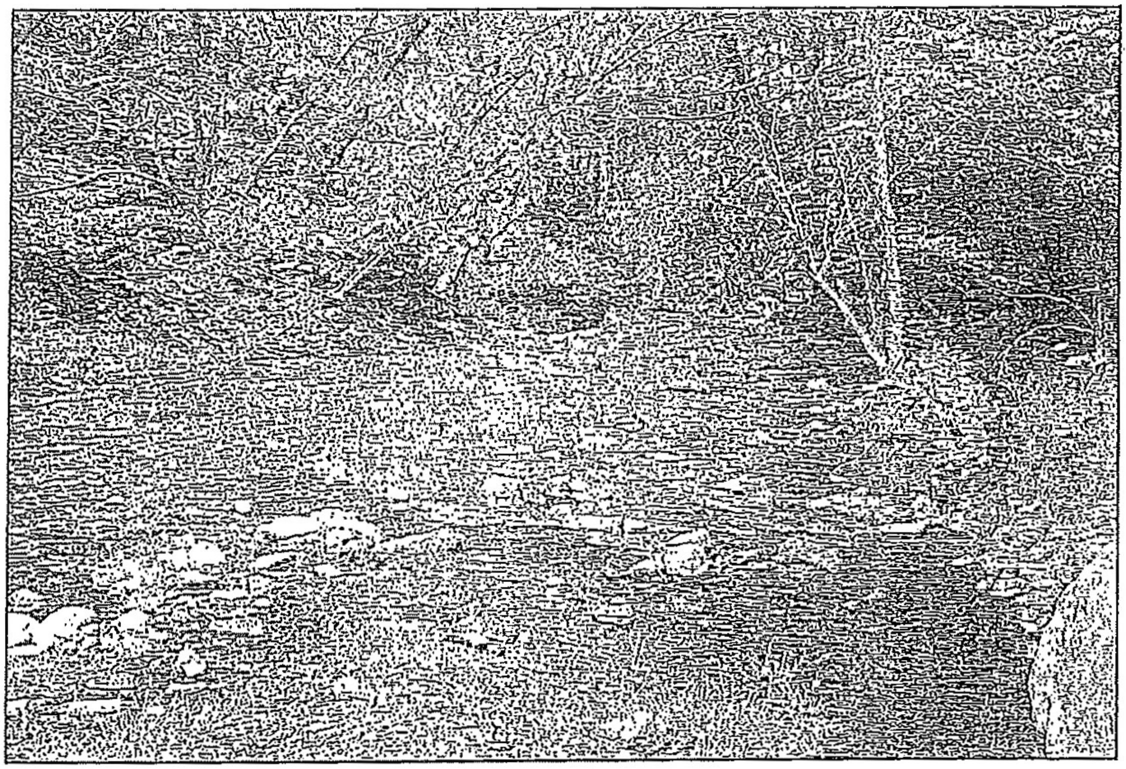
160 Attachment 6

Township of Paradise

SCHEDULE VI
Paradise Township Variable Width Riparian Buffer
[Added 11-19-2012 by Ord. No. 204]



PREPARED FOR:
PARADISE TOWNSHIP BOARD OF SUPERVISORS

PARADISE TOWNSHIP, MONROE COUNTY, PENNSYLVANIA

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I. INTRODUCTION AND BACKGROUND

A. Objective

It is the objective of this study to identify a methodology to establish the appropriate size of a variable width riparian buffer to protect and preserve the water quality of the streams and lakes in Paradise Township, Monroe County. The variable width buffer developed by this study is to be applied only to creeks, streams, rivers, ponds and lakes in the Township. It is not the intent of this study that the variable width riparian buffer developed by this project be applied to floodplains, wetlands, source water protection areas, wellheads or other water resources. The reason that this variable width riparian buffer is not intended for application around non-riparian water resources is that other regulatory programs and buffers presently exist which are designed to protect these features and achieve the goals of the individual programs regulating these resources.

It is important to note that this project did not consider wildlife habitat in the development of the variable width buffer. Buffers based on wildlife habitat can be exceptionally large, depending on the selected animal species and may not be spatially confined by any particular geographical feature such as a water body. With the overall objective of the variable width riparian buffer to protect and preserve the Township's streams and natural surface waters, the rationale for not developing the buffer width based on the habitat of wildlife species was that the variable width buffer will, by default, help preserve the aquatic habitat of aquatic species, while the habitat for terrestrial species may be very large, not well defined, and beyond the scope of this study.

B. Purpose and Goals

Riparian buffers adjacent to streams and water bodies are effective in protecting and preserving the aquatic health of these water resources. Numerous studies have examined and documented the capabilities of riparian buffers in filtering or reducing the concentration of nonpoint source pollutants (NPS) such as suspended solids, nitrogen, and phosphorous. Normally, increased urbanization and development results in higher loadings of these pollutants, and intensifies the need for preserving or expanding riparian buffers to protect and preserve existing water resources. Research conducted in this field of study has revealed many factors which influence the effectiveness of buffers at removing NPS pollutants from stormwater runoff and preventing their transfer to surface water resources. Establishment of a variable width riparian buffer strives to take each of these factors into account in order to provide consistent filtering capabilities for each of the surface water resources based on a variety of physical conditions which may exist adjacent to the surface waters.

The purpose of this riparian buffer project is to:

- Research existing studies and literature pertaining to riparian buffers in order to develop recommendations for a variable width buffer based on existing quantifiable data that is already documented and readily available;

- Identify parameters which affect pollutant generation potential and the effectiveness of riparian buffers in preserving water quality;

- Develop a variable width riparian buffer for the streams and water bodies in Paradise Township to protect and preserve the water quality of the Township's surface waters;

- Provide a Geographic Information System (GIS) based tool the Township may use to adjust buffer widths as new and more accurate geographic data becomes available.

Subsequent sections of this report document the procedure followed to achieve the purpose and goals of this study.

C. Supporting Studies and Research

A variety of reference materials were investigated and studied to identify applicable supporting information concerning riparian buffers. References investigated for this project included federal, state, and local regulations and guidelines; watershed organization studies and reports; and educational institution research papers and articles. The majority of the references researched did not provide useful quantifiable data pertaining to the buffer characteristics studied, but instead qualitatively investigated the general benefits of riparian buffers. In reviewing the remaining reference documents, general consistent trends regarding buffers became apparent between various sources investigated for this study. This allowed the number of references used for this project to be narrowed to a select few which contained the most salient information pertaining to variables that impact the effectiveness of buffers and those references that identified the most appropriate buffer width based upon one or more important variables. The following references were identified as the key references useful in the development of the variable width buffer tool (a full list of references which provided supporting data is included in Section I References):

- National Resources Conservation Service, Buffer Conservation Initiative.

- State of Pennsylvania, Pennsylvania Stormwater Best Practices Manual.

- State of New Jersey, New Jersey Stormwater Best Practices Manual.

- Chesapeake Bay Foundation, Forest Riparian Buffer Model Ordinance.

- Rhode Island Coastal Resources Management Council, Rhode Island Coastal Zone Buffer Program.

- Pennsylvania State University, Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality.

- Superior Watershed Partnership, A Model Riparian Buffer Implementation Plan.

Each of these sources provides data that either recommends a defined buffer width based on characteristics of the contributing drainage area and adjoining water resource or buffer; or correlates the effectiveness of buffers to a quantifiable buffer width (i.e. pollutant removal efficiency for various conditions). Investigation of the aforementioned references identified five key parameters which are essential to establishing a recommended buffer width. Each of these parameters is discussed in the next section.

D. Parameters Effecting Riparian Buffer Width

The five parameters identified in the reference documents and selected for application in this project which influence the effectiveness of riparian buffers are: 1) pollution potential of contributing drainage area; 2) buffer slope; 3) buffer soil type; 4) stream order; and 5) buffer vegetative condition. A description of each parameter and the effect on riparian buffer widths is discussed below.

1. Pollution Potential of Contributing Drainage Area

The activities that occur on the land and the type of land cover (i.e. residential, commercial, industrial, agriculture) directly affects the potential to increase the quantity and concentration of pollutants carried in stormwater runoff during storm events. For instance, a rural area with more open space and less impervious area is not typically expected to generate as many pollutants as a highly developed industrial site or high volume transportation facility (i.e. highway or parking lot). Generally, drainage areas with more impervious area are considered to have more pollutant potential than similarly sized areas that are pervious. However, this is not always the case as both agricultural land and golf courses can be significant contributors of NPS pollutants associated with sediment transport (i.e. suspended solids) and fertilizer application (i.e. nitrogen, phosphorous).

Initially it was thought to correlate pollutant potential to zoning within Paradise Township. The problem with using zoning to define pollutant potential is that within the Township there are certain land uses that are permitted within every zoning district which may result in a substantially different pollutant potential than indicated by the zoning district name (i.e. residential, business, etc.). For instance, in Paradise Township resorts are permitted in residential districts and parks are permitted in business districts. A more accurate means of identifying pollutant potential is to use land use information instead of zoning classification. Land use data identifies how each parcel of land is used instead of the type of uses that are most typical or are permitted within a given area or district.

Land use data for Paradise Township was obtained from the Monroe County Planning Commission. Table 1 displays the 12 different types of land uses predominantly found in Paradise Township. For this project, each of the land use types was classified as “low”, “medium”, “high”, or “very high” for pollutant generation potential. The classification of land use by pollutant potential was based upon how typical activities which occur around such land uses are normally perceived to impact pollutant concentrations in stormwater runoff from these land uses.

The relationship between pollutant potential, as identified by land use in this analysis, and buffer width is:

Land uses such as forest or parks with “low” pollutant generation potential require less buffer width than land uses such as industrial or agricultural sites with “very high” pollutant generation potential that require more buffer width to allow for filtration and infiltration to reduce the NPS pollutant loadings.

Table 1. Land Use Types in Paradise Township and Pollution Potential.		
Land Use Type	**Monroe County Land Use Codes**	**Pollution Potential**
Forest	921	Low
Vacant	911, 912	Low
Cultural, Public/Private Parks and Rec.	741, 765, 767, 771	Low
Residential	111, 141, 913	Medium
Hotels	151	High
Communication/Transportation/Utilities	411	High
Retail Trade	551, 591	High
Services	621, 691	High
Educational Services	681	High
Resorts and Group Camps	751	High
Agricultural	811, 829	Very High
Industrial	211	Very High

2. Buffer Slope

The slope of the Buffer affects the NPS pollutant reduction or removal ability of the buffer by influencing the amount of time it takes stormwater runoff carrying the NPS pollutants to flow through the buffer. As slope increases, surface runoff flows through the buffer more rapidly, decreasing the amount of time runoff spends in the buffer and decreasing NPS pollutant reduction capacity of the buffer. Increased buffer slope and corresponding decreased time in the buffer means that vegetation has less time to filter pollutants and the soil has less time to infiltrate stormwater runoff. The relationship of buffer slope to buffer width is:

Flat areas, or buffers with low slopes, require less buffer width than buffers with steep grades or high slopes to allow more time for the stormwater to reside within the buffer. Additional buffer width is required to attain similar NPS pollutant reduction as the slope of the buffer increases.

3. Buffer Soil Type

Soils are typically classified by infiltration potential or permeability, and are grouped into one of four types of Hydrologic Soils Groups (HSG). HSGs are identified as A, B, C, or D with HSG A soils having the highest infiltration potential and HSG D soils having the lowest infiltration potential. HSG A and HSG B soils have the greatest ability to infiltrate stormwater and reduce stormwater runoff while HSG C and HSG D soils have less ability to infiltrate stormwater and reduce stormwater runoff. When the infiltration capacity of the soil contained in a buffer is low, surface runoff remains high, and more NPS pollutants are conveyed through the buffer via the stormwater runoff to the surface water resources rather than being intercepted, filtered, and infiltrated into the ground by the buffer. The relationship of buffer soil type to buffer width is:

HSG A and HSG B soils, with higher infiltration potential, require less buffer width than HSG C and HSG D soils, with lower infiltration potential, to remove stormwater runoff and reduce NPS pollutants transported to surface water resources.

4. Stream Order

Stream Order is a classification system used to categorize streams and rivers based on the branching pattern of the waterways. Smaller streams, normally found in the headwaters of watersheds, typically have the lowest stream order (i.e. stream order = 1). When two, or more, smaller order streams join together they typically form the next larger order stream (i.e. two streams classified as stream order 1 combine to form a stream that is classified as stream order 2). The stream order increases as the water moves downstream through a watershed until the largest stream order occurs at the outlet of a watershed.

The largest watershed in Paradise Township is the Paradise Creek watershed. In the Paradise Creek watershed, the largest order stream is an order four stream (main stem of the Paradise Creek). The connection between stream order and NPS pollutants conveyed in stormwater runoff upon water quality is directly related to the amount of flow in the streams and rivers. Smaller order streams typically experience less flow than higher order streams and as such are more susceptible to the deleterious effects of NPS pollutant concentrations than larger order streams. Since the smaller order streams have less flow there is less opportunity to dilute the NPS pollutants conveyed to the stream in the stormwater runoff. Therefore, the same NPS pollutant concentration from a given type of land use will have more of an impact on a smaller order stream than on a higher order stream. The relationship of stream order to buffer width is:

Stream Order 3 and 4 streams, that normally have more flow than lower order streams, require less buffer width to preserve and protect the streams than order 1 and 2 streams with less flow, which require greater buffer widths to protect and preserve the water quality of the smaller streams.

5. Buffer Vegetative Condition

The ability for a riparian buffer to filter pollutants is contingent upon the vegetative condition of the buffer. A buffer containing large trees and dense undergrowth consisting of native plant species has a deeper and more complex root system than a buffer containing short turf grasses and as such is more effective in trapping and filtering pollutants. The relationship of buffer vegetative condition to buffer width is:

Indigenous forests with old growth trees and dense undergrowth consisting of native plant species requires less buffer width than turf grasses that are regularly cut and maintained as lawn or a similar landscaping practice consistent with land development.

E. Quantification of buffer parameters.

Several references reviewed for this study recommended minimum buffer widths that vary between 20 feet and 50 feet in order to provide water quality benefits. The National Resources Conservation Service (NRCS) as part of the 1996 Farm Bill started the National Conservation

Buffers Initiative to encourage the best use of all land. This initiative led to the development of the NRCS National Conservation Practice Standard for Riparian Forest Buffers which set a minimum buffer width of 35 feet that landowners should apply to reduce NPS pollution. In Pennsylvania, the minimum recommended buffer width cited in the Pennsylvania Stormwater Best Management Practices Manual is 35 feet. Although there were instances in the reference materials where the minimum buffer width was less than 35 feet, 35 feet was somewhat commonly cited as a minimum. Therefore, this research resulted in establishment of:

A thirty-five-foot absolute minimum buffer width.

The buffer shall be measured horizontally and perpendicular to the normal direction of flow in the channel, or radially outward from any surface water resource consisting of a pool of water such as a lake or pond. Stormwater management facilities that manage the rate or volume of stormwater runoff should be excluded from the buffer width contained in this document as stormwater management facilities typically implement other appurtenances and management practices to address the water quality of stormwater runoff.

The buffer width shall be measured starting at a point identified as the top of bank and measured outward away from the main channel or pool of water. The top of bank shall be defined as the first substantial change in slope between the side of the channel adjacent to the bottom of the stream and the surrounding natural terrain. In the absence of a clearly defined bank, the buffer shall be measured outward from the normal pool elevation which is unaffected by drought or other atypical or unusual hydrologic conditions.

Reference materials used for this project identified a wider range of recommended maximum buffer widths than minimum buffer widths. The maximum buffer width varied from 100 feet to widths in excess of 500 feet depending on the intended function of the buffer (i.e. flood protection, habitat preservation, wildlife management, water quality protection, wetland preservation, etc.). In Pennsylvania, the Department of Environmental Protection (DEP) in its Riparian Forest Buffer Guidance (Document No. 394-5600-001) recommends a minimum of 150 feet of buffer width for water bodies designated as Exceptional Value or High Quality waters. This 150-foot riparian buffer width is further supported by the draft revisions to Title 25, Chapter 102 of the Pennsylvania Code (per proposed August 21, 2010 Draft Changes), which identifies that the minimum Riparian Forest Buffer width for Impaired Waters and Special Protection Waters as 150 feet. These findings resulted in establishment of:

A 150-foot absolute maximum buffer width.

The rational for setting the maximum buffer width proposed by this study to 150 feet, established in the aforementioned references is as follows:

- Several references (i.e. Riparian and Wetland Buffers for Water Quality Protection, Setting Buffer Sizes for Wetlands) indicate that most of the pollutant removal occurs in the first 50 feet of the buffer, with the additional width helping to preserve the buffer but doing little to enhance its function.
- Many of the studies cited buffer widths either equal to or substantially smaller than 150 feet (i.e. Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality = 150 feet, the PADEP Stormwater BMP Manual = 35 feet)

- Since the draft changes to the Title 25, Chapter 102 of the PA Code set the buffer width for Exceptional Value or High Quality water resources at 150 feet without consideration of the variables that impact their effectiveness, it was considered that even under the poorest conditions a 150-foot buffer is sufficient to provide adequate buffering.

With the establishment of an absolute minimum and maximum buffer widths a methodology was required to objectively and systematically assign buffer widths for a range of conditions based on a variety of watershed and buffer characteristics that affect buffer performance. In order to develop the variable width riparian buffer, a range of potential buffer widths was established for each of the aforementioned five parameters presented in Section D based on the information obtained in the supporting reference materials investigated for this project.

For this approach to be equitable, a methodology was needed to assign buffer widths based on a variety of conditions, with the assigned overall widths equal to not less than the minimum value and not more than the maximum buffer width. Each of these parameters were weighted and scaled in order to determine the additional buffer width each component would contribute to the base buffer width (additional width added to the minimum thirty-five-foot buffer width) based upon the physical conditions in the Township. The additional buffer widths for each of the parameters were combined in such a way that the cumulative buffer width did not exceed the maximum width of 150 feet. The process used to define the prescribed buffer width for each parameter as well as the overall buffer width is as follows:

- Using the supporting research documents listed in Section C, ranges of raw buffer widths were developed:
    - For pollution potential (PP), the research of reference materials identified a minimum buffer width of 25 feet for sites adjoining riparian buffers with “Low” pollutant potential and a maximum buffer width of 100 feet for “Very High” sites with very high pollutant potential.
    - For buffer slope (BS), the research of reference materials recognized a minimum buffer width of 50 feet for buffers with a slope of 0% and a maximum buffer width of 150 feet for buffers with slopes of 25% or greater.
    - For buffer soil type (BST), the research of reference materials concluded 0 additional feet was necessary for Buffers with HSG A soils, and 50 additional feet were required for Buffers with HSG D soils.
    - For stream order (SO), the research of reference materials identified a minimum buffer width of 25 feet was necessary for order four streams and a maximum buffer width of 100 feet was required for order 1 streams.
    - For buffer vegetative condition (BVC), the research of reference materials showed 0 additional feet was required for “Indigenous Woods” and 50 additional feet for “Turf Grass”.

- This resulted in the following ranges (maximum — minimum) for each parameter:
    - Pollution Potential (PP) (based upon land use): 75 feet
    - Buffer Slope (BS): 100 feet
    - Buffer Soil Type (BST): 50 feet
    - Stream Order (SO): 75 feet
    - Buffer Vegetative Condition (BVC): 50 feet

- Because the maximum buffer width cannot exceed 150 feet, the above ranges were scaled to provide actual additional widths based on each parameter's weighted contribution:
  - A range of 50 feet (Buffer Soil Type and Buffer Vegetative Condition) equates to a weight of 1.0.
  - A range of 75 feet (Stream Order and Pollution Potential) equates to a weight of 1.5.
  - A range of 100 feet (Buffer Slope) equates to a weight of 2.0.

- A weight of one is equivalent to 16.4 feet of additional buffer width, a weight of one and three-quarters (1.75) is equivalent to 24.6 feet of additional buffer width and a weight of two is equivalent to 32.9 feet of additional buffer width.
  - For Buffer Soil Type and Buffer Vegetative Condition: the most critical condition (i.e. HSG D Soils with Turf Grass) would add 16.4 additional feet each to the minimum buffer width of 35 feet. In the best possible conditions (HSG A Soils with Indigenous Woods), these characteristics would add no additional width to the prescribed buffer width.
  - For Stream Order and Pollution Potential: the most critical condition (Stream Order 1 and Very High Pollution Potential) would require an additional 24.6 feet for each parameter to be added to the minimum buffer width of 35 feet. In the best possible conditions (Stream Order 4 and Low Pollution Potential) these characteristics would add no additional width to the prescribed buffer width.
  - For Buffer Slope: the most critical condition (Buffer Slope ≥ 25%) would require an additional 32.9 feet be added to the minimum buffer width of 35 feet. In the best possible conditions (Buffer Slope = 0%) would add no additional width to the prescribed buffer width.

- The intermediate widths assigned for the various conditions that occur between the most critical condition and the best possible condition for each parameter were developed based on similar distributions as identified in the reference materials listed in Section C.
- The formula used to calculate the minimum buffer width is:

Buffer Width(ft) = Base Buffer Width + PP Width + BS Width + BST Width + SO width + BVC Width

Table 2 displays the ranges of additional buffer widths to be added to the base buffer width of 35 feet for each parameter described in Section C.

Table 2. Additional Buffer Widths for Each Parameter

Pollution Potential[1] (PP)		**Buffer Slope (BS)**		**Buffer Soil Type (BST)**		**Stream Order (SO)**		**Buffer Vegetative Condition (BYC)**	
Pollution Potential	**Width Added (feet)**	**Slope (%)**	**Width Added (feet)**	**HSG**	**Width Added (feet)**	**Stream Order**	**Width Adde d (feet)**	**Vegetation Type**	**Width Added (feet)**
Low	0	0	0	A	0	4	0	Indigenous Woods	0
Medium	8.2	5	6.6	B	4.9	3	8.2	Restored* Woods	11.5
High	16.4	10	13.1	C	8.2	2	16.4	Turf Grass[2]	16.4
Very High	24.6	15	19.7	D	16.4	1	24.6	[2]For all other vegetative conditions of buffer not listed above use Turf Grass.	
[1]Use Table 1 and land use of property adjoining buffer, and/or draining to buffer, to identify pollution potential.		20	26.3						
		25+	32.9						

* Restored woods is intended to mean the planting of non indigenous wooded areas with native plant species in a manner that is consistent with the specifications for Riparian Buffer Restoration as described in the Pennsylvania Stormwater Best Management Practice Manual. To apply the restored woods condition it is recommended that the Township require the applicant to provide the Township with a performance guarantee to ensure the restored woods is sustainable.

Table 3. Example of Combination of Conceptual Buffer Parameters Resulting in Extreme Buffer Widths

Smallest Potential Buffer Scenario			**Largest Potential Buffer Scenario**		
		Add:			Add:
Pollution Potential	Low	0 feet	Pollution Potential	Very High	24.6 feet
Buffer Slope (%)	0	0 feet	Buffer Slope (%)	25+	32.9 feet
Buffer Soil Type (HSG)	A	0 feet	Buffer Soil Type (HSG)	D	16.4 feet
Stream Order	4	0 feet	Stream Order	1	24.6 feet
Buffer Vegetative Condition	Indigenous Woods	0 feet	Buffer Vegetative Condition	Turf Grass	16.4 feet
	Base Buffer Width	35 feet		Base Buffer Width	35 feet
	Total Buffer Width	35 feet		Total Buffer Width	150 feet

Table 3 demonstrates two conceptual extreme conditions for the smallest and the largest potential buffer widths that may occur in the Township using the additional buffer widths listed in Table 2. Under optimum conditions such as low pollutant potential, good soils, a flat buffer slope, a high stream order and a buffer consisting of indigenous woods, the minimum buffer size would not be larger than the base buffer width of 35 feet. In contrast, under less than ideal conditions such as very high pollution potential, steep buffer slopes, poor soil conditions, a low stream order, and a buffer vegetative condition consisting of turf grass the buffer would be 150 feet. In other words, the buffer for a common stream that may be designated as a common cold water fishery could conceivably require the same buffer as an exceptional value stream if the conditions required the additional width.

The example shown in Table 3 is a rudimentary example of two potential scenarios for assigning the buffer width. There are many different combinations of the identified parameters that would result in an assigned buffer varying anywhere from 35 to 150 feet. To determine the appropriate additional width for each of the parameters the following guidelines are recommended:

- Pollution potential shall be based on the land use for the adjoining parcels contributing stormwater runoff to a buffer.
- The weighted average slope of the buffer shall be calculated from a point situated at the top of the bank and extended horizontally 150 feet away from surface water. The land slope of the buffer shall be rounded up to the nearest increment of 5% to identify the appropriate additional buffer width associated with buffer slope.
- A weighted average of the buffer soil type shall be determined based upon the amount of area each HSG soil type covers within 150 feet of the top of bank of the protected surface waters.
- The lowest stream order adjoining a buffer should be used to determine the appropriate contribution to the overall buffer width. For surface waters that do not have a stream order assigned, the lowest stream order of either the watercourse contributing flow or receiving flow from the surface water shall be used to assign a stream order. In the case of a surface water that is not connected to a stream network and does not have an assigned stream order, a stream order of 1 shall be assumed.
- The buffer vegetative condition shall be based upon the overall condition of the proposed buffer situated within 150 feet of the top of bank of the protected surface waters.
- The appropriate buffer width for each bank of a stream shall be determined independently from the opposite bank and based upon the parameters that occur only on the respective bank of the stream where the buffer is to be established.

F. Variable Width Buffer Mapping.

After developing the formula to assign the size of a variable width buffer, the following data sets were used with Geographic Information Systems (GIS) to create a buffer map for Paradise Township based upon existing conditions.

- Pollution Potential - Derived from land use as designated on parcel data obtained from Monroe County Planning Commission.
- Buffer Slope - Derived from United States Geologic Survey (USGS) 10 m DEM.
- Buffer Soils Type-Derived from United States Department of Agriculture (USDA) Soils.
- Stream Order - Pennsylvania DEP Ordered Streams.
- Buffer Vegetative Condition - Derived from National Land Cover Dataset (USGS 2005).

Raw buffer widths were computed for each bank of the surface water resource independently. After completing the initial buffer width computations, each of the buffers were rounded up to the nearest increment of five feet of buffer width. Therefore, the left bank of the stream may have a different buffer width assigned to it than the right bank of the stream depending on the characteristics of the buffer and the five key parameters used in the analysis. To reduce the number of buffer sizes on the map each of the buffer widths was grouped into a range of similar buffer widths, based on fifteen-foot increments, to create five different size buffers across the Township. Each of the five different buffers was assigned the largest buffer size to create the Township buffer map (i.e. 55 feet, 70 feet, 85 feet and 120 feet).

After creating the Township buffer map, the data sets were checked to see if the buffer widths determined by the process were logical based on the individual parameters identified at several key locations. The buffer widths assigned to the various locations in the Township appeared appropriate based upon the pollution potential (land use), buffer slope, buffer soils, stream order and vegetative condition at these locations. Thus, upon review of the map, the assigned buffer widths appeared logical. Surface waters with lowest stream order, or waterways receiving the highest pollutant loadings, were assigned the largest buffer and higher order streams with low pollution potential and good soils were assigned the lowest buffer width.

The buffer widths shown on the Township Buffer Map are based upon the existing conditions as identified in the data sets used to develop the map. If more accurate data becomes available, such as the type of data collected by individual site topographic surveys and aerial imagery, the buffer widths shown on the Township Buffer map could be revised using the formula developed by this project to assign a revised buffer width based on the more accurate site data. Furthermore, since the buffer widths shown on the map are based on the existing condition only, as development occurs in the Township the buffer width will likely change depending on what is proposed for a given development site. For instance, if a wooded site is cleared and replaced with residences the buffer would need to increase. Correspondingly, if an agricultural site, is replaced with a park or residences, or as the grading on the site is altered, the size of the buffer could potentially get smaller than the width developed for the existing condition. The valuable characteristic of the riparian buffer tool developed by this project is that the buffer width can be adjusted as needed based on better data or for changes that occur at a development site.

G. Hypothetical Example of Variable Width Buffer Establishment.

The following is a hypothetical example showing how the size of the variable width buffer is established. Figure 1 illustrates the location of a hypothetical stream segment and the topography of the surrounding contributing drainage area. Both banks of the stream are covered with indigenous woods, the soils consist of soils from Hydrologic Soil Group C, and this segment of the stream has a Stream Order Classification of 4. The contributing drainage area on the north bank consists predominantly of high density residential and on the south side the drainage originates predominantly from a transportation facility (highway). The natural terrain within 150 feet of the stream consist of multiple slopes, therefore the slope of the stream is calculated using a weighted average of the slope. Figure 2 shows a cross section of the channel, floodplains and buffer.

Figure 1. Buffer Example

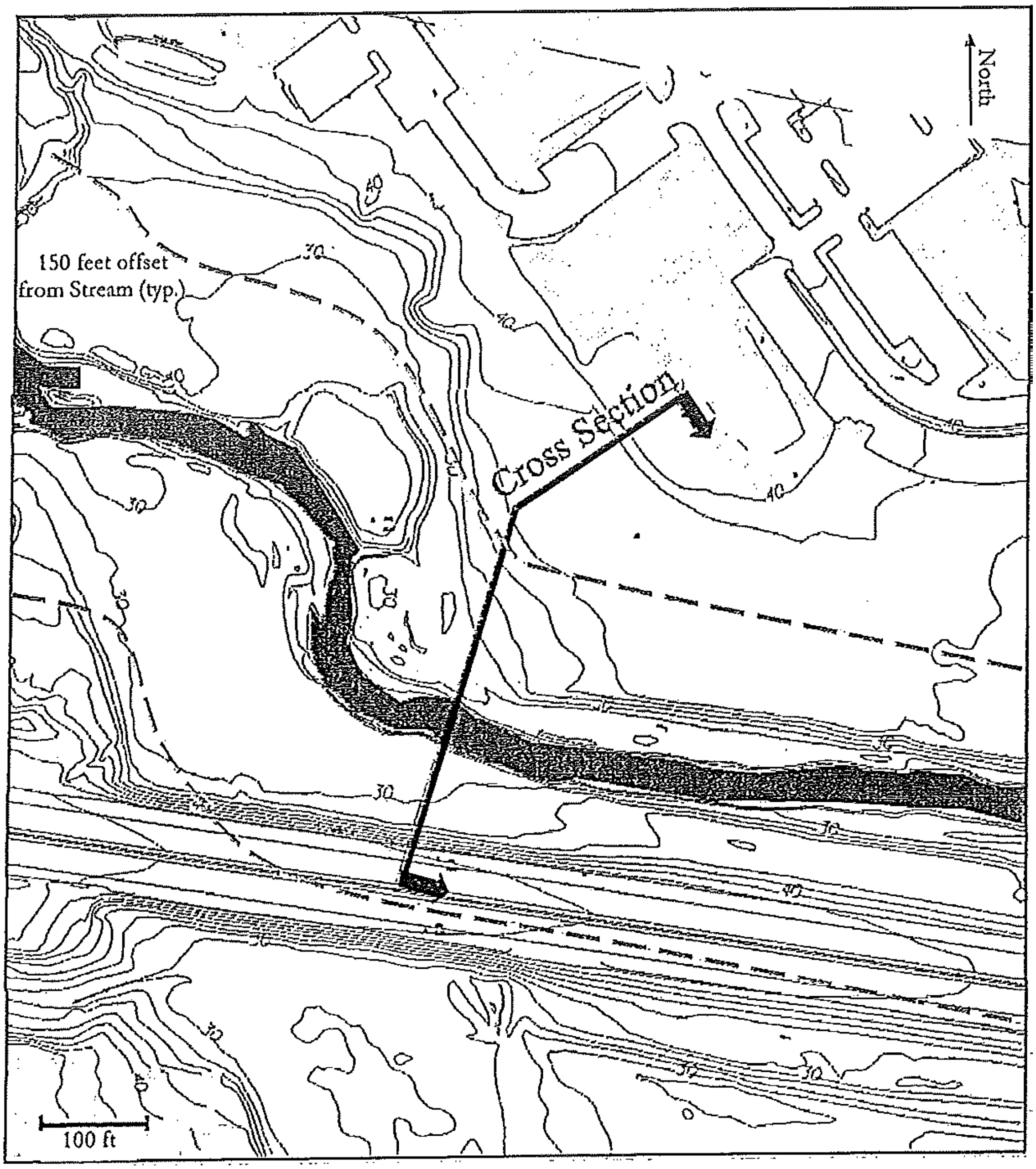
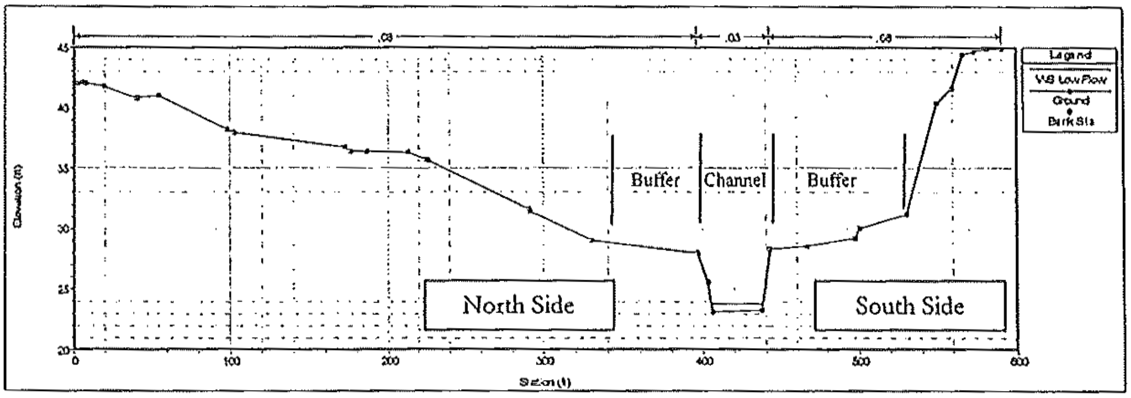


Figure 2. Cross Section of Channel and Potential Buffer Area



North Buffer:

Pollution Potential: Land Use of Contributing Drainage Area is High Density Residential Buffer Slope: Non uniform slope within 150 feet of stream, use weighted slope

Weighted slope = (% slope 1)(length of slope 1) + (% slope 2)(length of slope 2) / (length of slope 1 + length of slope 2)

Weighted slope = (6.3%)(102 feet) + (1.6%)(48 feet) / (102 feet + 48 feet) = 4.8% (round to 5)

Soils: HSG C Soils
Stream Order: 4
Buffer Vegetative Condition: Indigenous Woods

South Buffer:

Pollution Potential: Transportation
Buffer Slope: Non uniform slope within 150 feet of stream, use weighted slope

Weighted slope = (1.0%)(25 ft) + (2.1%)(35 ft) + (46.6%)(30 ft) + (46.6%)(35 ft) + (12.3%) (10 ft) + (3.0%)(15 ft) / (25 ft + 35 ft + 30 + 35+ 10+ 15) = 13.5%

Weighted slope = 13.5 (round to 15)

Soils: HSG C Soils
Stream Order: 4
Buffer Vegetative Condition: Indigenous Woods

Table 4. Buffer Width Example

North Buffer			**South Buffer**		
		Add:			Add:
Pollution Potential	Medium	8.2 feet	Pollution Potential	High	16.4 feet
Buffer Slope (%)	4.5	6.6 feet	Buffer Slope (%)	13.5	13.1 feet
Buffer Soil Type (HSG)	C	8.2 feet	Buffer Soil Type (HSG)	C	8.2 feet
Stream Order	4	0 feet	Stream Order	4	0 feet
Buffer Vegetative Condition	Indigenous Woods	0 feet	Buffer Vegetative Condition	Indigenous Woods	0 feet
	Base Buffer Width	35 feet		Base Buffer Width	35 feet
	Total Buffer Width	58 feet		Total Buffer Width	73 feet

H. Applicability

Upon consideration of the proposed draft changes to the Title 25, Chapter 102 of the Pennsylvania Code and with an understanding that all of the streams and surface waters in the Township are designated by the PADEP as either a High Quality or Exceptional Value, the utility of this variable width buffer is somewhat uncertain. The draft changes proposed Title 25, Chapter 102 of the Pennsylvania Code assigns a mandatory minimum buffer width of 150 feet for all impaired streams and special protection waters (i.e. High Quality or Exceptional Value). However, the draft changes to Chapter 102 include several exceptions where the proposed buffer limits do not apply which include among others:

- Project sites that are greater than 150 feet from a river, stream, creek, lake, pond or reservoir;
- Activities involving less than one acre of earth disturbance;
- Activities that do not require an earth moving permit;
- Road maintenance activities;
- Single family homes that are not part of a larger subdivision.

The variable width buffer established in this report could conceivably be applied by the Township in instances where the proposed changes in the state code allows for these exceptions. This would ensure that all surface waters in the Township will have a minimum width buffer established to protect them regardless of whether Title 25, Chapter 102 of the state code applies.

It is not the intent of this project to develop an ordinance to apply the variable width buffer developed by this project within the Township, define the activities that may be permitted within a defined buffer, divide the buffer into multiple zones or describe with complete specificity the conditions that must exist within or near the buffer to develop justification for establishing the appropriate width of the buffer. Paradise Township will most likely need to address these variables as part of the consideration of how it intends on applying the variable width buffer established by this project.

I. Conclusion

After investigating numerous reference materials related to riparian buffers, a base buffer width of 35 feet was established. Further investigation of the reference materials identified 5 key parameters that impacted buffer performance. These parameters included pollution potential of contributing drainage area, buffer slope, buffer soils, stream order and vegetative condition of the buffer. A formula was provided which assigned additional buffer width to the base buffer width for the condition of the five aforementioned parameters. The maximum potential buffer width that could conceivably be applied to any single side of the creek was set at 150 feet.

Applying the variable width buffer formula using several data sets with GIS resulted in the development of five different sizes of buffers identified on the buffer map for streams within the township ranging from 55 feet up to 120 feet wide. The buffer is to be measured outward horizontally away from the surface water resource starting from a point at the top of the bank of the surface water resource and measuring upland and away from the surface water. Each bank of the stream has its own buffer width developed and applied independently from each other based upon the attributes of the contributing drainage area, stream and buffer which exist on each side of the stream.

The resultant Township Buffer map was checked against the data used to develop the map and was considered to be accurate and logical based on known conditions in the Township and the location and type of surface waters needing protection or preservation. The formula used to develop the Township Buffer map can be recalculated by the Township as more accurate data becomes available, or as development or changes in the watershed indicate a modification to the buffer width is warranted.

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