



Raritan Basin Watershed Management Project

Water Resources Protection Open Space Criteria

INTRODUCTION

In 1999, the New Jersey Water Supply Authority, New Jersey Department of Environmental Protection, and Raritan Basin stakeholders formed a partnership to develop a watershed management plan for the Raritan Basin. The Raritan Basin's water resources provide drinking water for 1.2 million people from its surface waters, habitat for wildlife and plants, and large amounts of drinking, irrigation, and process water from its underlying aquifers. The intent of the partnership and watershed management plan is to manage the use of the basin's water resources and protect and preserve those resources for the future.

Through the Raritan Basin Project, a subcommittee of interested stakeholders from the Millstone Watershed Management Committee, decided to develop a list of criterion to be used for choosing open space that protects water resources. To avoid the duplication of work and rather than forming additional committees for the other Watershed Management Areas the within the basin, stakeholders from the North and South Branch WMA and the Lower Raritan WMA participated in the criteria. Since the criteria were most likely to be similar for each WMA, one set of criteria would be developed for the basin and later tailored to each WMA as necessary. The subcommittee and project staff began meeting in the fall of 2001 to brainstorm and then narrow watershed properties that protect water resources. The participants in the criteria development are listed in Appendix A.

Open space is a known and effective means of protecting water resources; however, open spaces are rapidly disappearing due to the intense development pressure experienced in central New Jersey. Urbanization and suburbanization can and do impair water resources. The increase in impervious surfaces (roads, sidewalks, parking lots, and roofs) causes a variety of problems for water resources including the faster delivery of stormwater to streams causing erosion; delivery of warmer water to water bodies impairing biota; the deposition and wash-off of pollutants from vehicles causing pollution; the reduction of ground water infiltration causing well losses and reduced stream flows; and, the removal of vegetation (forest, meadows, wetlands) that can provide some treatment of stormwater before delivery to water bodies. Lawns, both corporate and homeowner, also adversely affect water resources if fertilizers are applied in excess and are washed into local water bodies by stormwater.

As development pressure is high and the three watershed management areas have experienced open space losses, the stakeholders decided to address the preservation of open space within the Raritan Basin by providing open space criteria for water resources protection to land acquisition entities. The criteria can be used in ranking parcels for acquisition, easements, and stewardship by entities that preserve or protect open spaces as well as provide additional justification for purchases or other preservation techniques. In developing the criteria, the stakeholders wanted to provide land acquisition entities with a means to integrate water resources protection into their existing methodology for ranking or targeting parcels for acquisition or easements. The criteria can be used in concert with an entity's existing criteria, with their criteria if method does not already consider water resources protection, or can be used directly as a new focus for protection efforts.

THE CRITERIA

To evaluate if a parcel or area is protective of water resources, the mechanisms for water resources protection need to be determined. The threats to water resources emanate from loss of vegetation (particularly forests and wetlands); placement of impervious surfaces over high ground water recharge areas; increased runoff; and activities in riparian areas and floodplains. Open spaces that limit these threats protect water resources.

The subcommittee brainstormed a list of 20 criteria that protect water resources (See Table 1). Because this list focuses primarily on water resources it may not address all of a land conservation entity's goals.

A. Recharge Areas	H. Floodplains and Riparian Corridors	O. Trout Production Streams
B. Wellhead Protection Areas	I. Wetlands	P. Vegetative Cover
C. Drinking Water Source Areas	J. Mature Forest	Q. Soil Type
D. Headwaters	K. Threatened or Endangered Species	R. Proximity to Water Body
E. Water Pollution Hazard Areas	L. Contamination and Previous Use	S. Land Use/Land Cover
F. Areas with Steep Slopes	M. Size of Parcel	T. % Impervious Surface
G. Lakes and Ponds	N. Length of Stream	
Criteria are listed in no particular order. These criteria were specifically included for their protection of water resources.		

A GIS (geographic information system) contains linked spatial and tabular data in a group of files that are used together and called a coverage. To facilitate the dissemination of the criteria, the open space group decided to develop a GIS-based "model", similar to the Upper Delaware Watershed's Water Resources Evaluation System¹ (www.upperdelaware.org). The subcommittee felt that by developing a model to share with interested local and regional entities, these organizations would be spared from having to undertake some of the more difficult calculations and analyses themselves to determine if and how an open space would protect water resources. In addition, the maps generated from GIS could be provided to land trust organizations without GIS capabilities.

GIS Coverages for the Model

The open space group consolidated the 20 initial criteria into 4 GIS coverages that encompass water resources protection criteria. In addition, the subcommittee recommended use of the land use and existing open space coverages to exclude developed and preserved areas. The Table 2 outlines the GIS coverages and the criteria represented by each. An explanation of the chosen coverages is presented below. Appendix B contains the source information for all of the coverages used in developing the model.

Wellhead Protection Areas: Wellhead Protection Areas show the spatial extent from where ground water flows into a well for a specific time period. A Wellhead Protection Area is divided by multiple times of travel: Tier 1 (2 years), Tier 2 (5 years), Tier 3 (12 years). Tier 1 and Tier 2 are used in this open space model to indicate the spatial extent in which ground water pollution, if it occurs, poses a significant threat to the water quality of the well. Tier 3 was not included in this model because it allows a longer time frame in which to manage a threat to water quality. To focus attention on

¹ The Upper Delaware Watershed's Water Resource Evaluation System model could not be implemented "as is" in the Raritan Basin, because a different Riparian Area Methodology was used in each region.

GIS Coverage to be Used	Initial Criterion/Criteria Addressed by Coverage (see Table 1)	Protection Area Includes
1. Wellhead Protection Areas (WHPA)	Wellhead Protection Areas (A) Recharge Protection (B)	Undeveloped portions of Tiers 1 & 2
2. Ground Water Recharge (NJGS GSR-32 calculation)	Ground Water Recharge (B)	Open spaces within the undeveloped areas of highest recharge rate that comprise 25% of ground water recharge volume for each HUC-11 watershed
3. Riparian Areas (Raritan Project coverage)	Headwaters (D); Floodplains (H); Lakes and ponds (G); Wetlands (I); Proximity to Water Body (R); Trout Production Streams (O)	Use complete Raritan Project methodology (Riparian soils, wildlife corridor, 100-yr floodplain, wetlands) for existing riparian areas
4. Threatened and Endangered Wildlife Species Habitat	Threatened and Endangered Species (K); Mature Forests (J); Vegetative Cover (P); Wetlands (I)	Emergent wetlands and forested wetlands that protect various categories of T&E species, from NJDEP Landscape Project; plus dense forest area as defined by Spruce Run Initiative
5. Preserved Open Space	Preserved Open Space (Determines proximity and linkage of preservation targets to existing, dedicated open space)	All open space identified in Green Acres and NJ Conservation Foundation coverages, plus others as available
6. Land Use/Land Cover or Percent Impervious Cover	LU/LC (S); Percent Impervious (T); Vegetative Cover (P)	NJDEP 1995/97 Land Use/Land Cover

potentially available open space, developed lands within a Wellhead Protection Area were excluded from this coverage. Of note, this GIS coverage, available from NJDEP, only includes wellhead protection areas for public community supply wells. Individual home or property owner wells are excluded.

Ground Water Recharge Rates: Ground water recharge rates were calculated using NJGS Method GSR-32, which estimates ground water recharge below the plant root zone using municipality-based climatic, soil type, and land use/land cover information. (Note: only a portion of ground water recharge becomes aquifer recharge.) For the Raritan Basin, ground water recharge rates were developed from the NJDEP's 1995/1997 land use/land cover data. Both the volume and the rate of recharge were used to develop this criterion. The goal of the criterion is to protect areas that contribute the largest amount of recharge in the shortest amount of time. The subcommittee determined that the area that contributes 25 percent of the recharge should be preserved. The analyses were performed by HUC 11 subwatershed to minimize the effects of local climatic and geologic conditions within the Raritan Basin and ensure that areas determined to be protective of groundwater recharge were not concentrated in one area or one WMA. To determine the area that preserves the top 25 percent of volume, the volumes for each land use polygon were ranked by recharge rate then cumulatively summed to equal 25 percent of the annual recharge volume. This ensures that properties desirable to be preserved recharge the quickest. In doing so, large slowly recharging areas will not be selected over quickly recharging areas based on volume alone.

Riparian Areas: The Raritan Project methodology defines riparian areas as the undeveloped areas adjacent to streams that either are within the 100-year flood prone areas, contain hydric soils, contain streamside wetlands and associated transition areas, or are within a 150-foot or 300-foot wildlife passage corridor on both sides of a stream (with the width dependent on stream order). The riparian areas coverage used in the model addresses the following criteria listed in Table 1: Headwaters (D), Floodplains (H), Lakes and Ponds (G), Wetlands (I), Length of Stream (N), Proximity to Water body (R), Soil Type (Q) and Trout Production Streams (O). Data to develop the riparian areas coverage were obtained from FEMA (floodplains), NRCS (hydric soils) and the NJDEP

hydrography (wetlands, lakes and ponds, stream information). The Upper Raritan Watershed Association performed the analyses to create a riparian area coverage for the entire Raritan Basin.

(Threatened and Endangered) Wildlife Species Habitat: Threatened and endangered wildlife species habitat information was derived from the New Jersey DEP Division of Fish and Wildlife's Landscape Project data. This data was included in the model to represent high quality vegetated areas, which are beneficial to and protective of water resources. The habitat coverage addresses the following criteria shown in Table 1: Threatened and Endangered Species (K), Mature Forests (J), Vegetative Cover (P), and Wetlands (I). The Landscape Project has developed GIS coverages for several types of habitat, including grasslands, forested wetlands and emergent wetlands. The subcommittee chose to concentrate on forested and emergent wetlands. Each habitat can be broken into five levels: that which harbors Federal T&E species, those which harbor State Endangered species, State Threatened species or Species of Special Concern, and that which may provide Suitable Habitat for T&E species. In addition, a "dense forest" layer was incorporated into the wildlife species habitat coverage. The Spruce Run Initiative defined dense forests as woodlands in which core areas exist beyond a 400-foot buffer from the forest edges. By definition, all of the areas in the wildlife species habitat coverage are non-urban. The dense forest coverage was created using NJDEP 1995/97 land use land cover data.

Preserved Open Space: The preserved open space coverage will be a compilation of all known open space and preserved areas including federal and state-owned lands, land trust properties, county and municipal open space properties, etc. The Green Acres Program and various land trusts have available data. This coverage will allow land trust organizations to coordinate their efforts in making greenways or aggregating preserved lands to further protect water resources. This coverage will be used to exclude areas from the model since they are already preserved.

Land Use/Land Cover: NJDEP's 1995/1997 Land use/ land cover data was used to create a file of developed areas to exclude from the model. This data is available via the NJDEP web site.

Known Contaminated Sites: The subcommittee strongly recommends referring to the Known Contaminated Sites coverage. This coverage was updated by NJDEP in 2001 and is also available via their website. Land preservation organizations can use this information to find potential troublesome sites near lands desired for preservation.

Caveats/ Omissions

Some of the 20 criteria originally brainstormed are not explicitly represented. For instance, Drinking Water Source Areas (C) are not specifically mapped; however, surface water intakes are located within the Riparian Area coverage, and community ground water wells are located within the Wellhead Protection Area coverage. Soil Type (Q) was used to estimate recharge potential in the Groundwater Recharge coverage. Steep Slopes (F) were not included because available digital elevation models are not of sufficient detail. Size of Parcel (M) and Length of Stream (N) are criteria that need to be determined when a specific piece of property is under consideration. Most counties lack digitized parcel data, making a basin-wide analysis of target parcels impossible at this time.

GIS Model Form

The GIS model aggregates the first 4 water resources protection open space criteria shown in Table 2 into a single coverage. Each criterion of the model was given the same weight. For an area of land, the number of criteria met was calculated resulting in each area receiving a tally from 0-4. Figure 1 shows an example area with different WRPOS criteria values. The darkest areas denote open spaces that provide the most protection for water resources. The database file associated with the final GIS coverage contains the information about which criteria were met. Also contained in the coverage's

database are whether or not an area of land is urban or preserved open space. These were added to the database so that developed land and preserved open space would not be included as desirable even if some criteria were met. More detailed information about the development of the GIS model is located in Appendix C.

Parcel data were available for only a portion of the basin and were not used to develop the water resources protection open space (WRPOS) criteria. Parcel data in GIS can be plotted over the WRPOS criteria to obtain the actual number of criteria the parcel meets. Without parcel data or access to GIS, the WRPOS criteria map can be used to approximate the number of criteria met.

The GIS WRPOS "model" is available as a map and as a coverage on the Raritan Basin Project web site (www.raritanbasin.org) or on CD from the NJWSA Watershed Protection Unit.

Water Resources Protection Open Space Criteria Incorporation

The Water Resources Protection Open Space Criteria are presented to the stakeholders and land preservation organizations as indicators for determining if a piece of property targeted for open space is protective of water resources. Land preservation organizations may have their own goals and objectives for the acquisition of open spaces and the Raritan Project asks them to include the protection of water resources as a special criterion in their decision to purchase or protect parcels of land. A new State law requires that Green Acres give special weight to the protection of water resources in its open space scoring system. **NOTE:** Because these areas are important for water resources protection, they are NOT generally suitable for active recreational facilities; rather, the natural resources of these lands should be protected from harm.

Land preservation organizations can incorporate the WRPOS criteria into their existing criteria in many ways depending on their current scoring or ranking system and what criteria are already used in that scoring or ranking system. As always, users should be aware of issues regarding data resolution – the model helps provide targets, but only site-specific assessments can verify the model.

APPENDIX A

List of Open Space Criteria Subcommittee Members

APPENDIX B

GIS Data Sources

GIS Coverages:

- Wellhead Protection Areas – NJ Department of Environmental Protection (NJDEP)
- Emergent Wetlands – NJDEP Division of Fish and Wildlife Landscape Project
- Forested Wetlands – NJDEP Division of Fish and Wildlife Landscape Project
- Ground Water Recharge – Upper Raritan Watershed Association
- Riparian Area – Upper Raritan Watershed Association
- 1995/97 Land Use Land Cover – NJDEP OIRM BGIA
- 2002 Green Acres Preserved Open Space – NJDEP Green Acres Program
- Watershed Management Areas – NJDEP OIRM BGIA
- Watersheds (Hydrologic Unit Code 11) – NJDEP GIS

APPENDIX C

Detailed GIS Model Development Process

GIS Process:

- Clipped all GIS layers to the Raritan Basin
- The "Dense Forest Area" layer was developed by creating a 400-foot buffer inside selected forest polygons from 1995/97 Land Use/Land Cover layer
- The "Urban Area" layer was created by extracting all "Urban" polygons from the 1995/97 Land Use/ Land Cover layer
- Using ESRI's ARCGIS 8 Spatial Analyst Extension, all GIS layers were converted to GRID coverages
- GRID coverages were assigned a grid cell resolution (98.454649*98.454649 feet)
- The Emergent Wetlands, Forested Wetlands and Dense Forests coverages were merged together to create a single "Vegetation" coverage
- Green Acres coverages (Conservation Easements, Federal and Utility, County and Municipal, State and Non-Profit preserved lands) were merged together to create a single "Open Space" coverage
- Each coverage was assigned a unique cell value, where criteria were present:
 - Wellhead Protection Areas – 1
 - Riparian Area – 10
 - Ground Water Recharge –100
 - Vegetative Cover – 1000
 - Urban Area – 9999
 - Open Space – 10000
 - Watershed Management Areas
 - North & South Branch – 800000
 - Lower Raritan – 900000
 - Millstone – 1000000
- Where there was an absence of criteria, a value of 0 was assigned to each grid cell
- All seven coverages were merged together and values were summed by grid cell
- The result is a coverage that contains cell values ranging from 0 to 1019999
- This GRID coverage was then converted to a shapefile
- Attributes were added to the GIS layer derived from the cell values

GIS Model Database Codes**GRIDCODE**

Values range from 0 to 1019999 (see below)

1	Presence of the wellhead protection area criterion
10	Presence of the riparian area criterion
100	Presence of the ground water criterion
1000	Presence of the vegetation criterion
9999	Urban Area as of 1995 Land Use/Land Cover data
10000	Within preserved open space as of 2002 Green Acres data
800000	Within the North and South Branch Raritan WMA
900000	Within the Lower Raritan WMA
1000000	Within the Millstone WMA

MODELCODE

As above, values ranging from 0 to 9999 only

CRITERIA

None	No criteria present
One	One criterion present
Two	Two criteria present
Three	Three criteria present
Four	All criteria present
Urban	Urban Area

CRITERIAOS

As above, with the addition of the value "Open Space" where 2002 Green Acres preserved open space is present.

WMA

Watershed Management Area (NS Branch, L Raritan, Millstone)

VEG

TRUE – Presence of Vegetative criterion

GWR

TRUE – Presence of Ground Water Recharge criterion

RIP

TRUE – Presence of Riparian Area criterion

WHP

TRUE – Presence of Wellhead Protection Area criterion

GA_OS

TRUE – Within preserved open space

URBAN

TRUE – Within Urban area