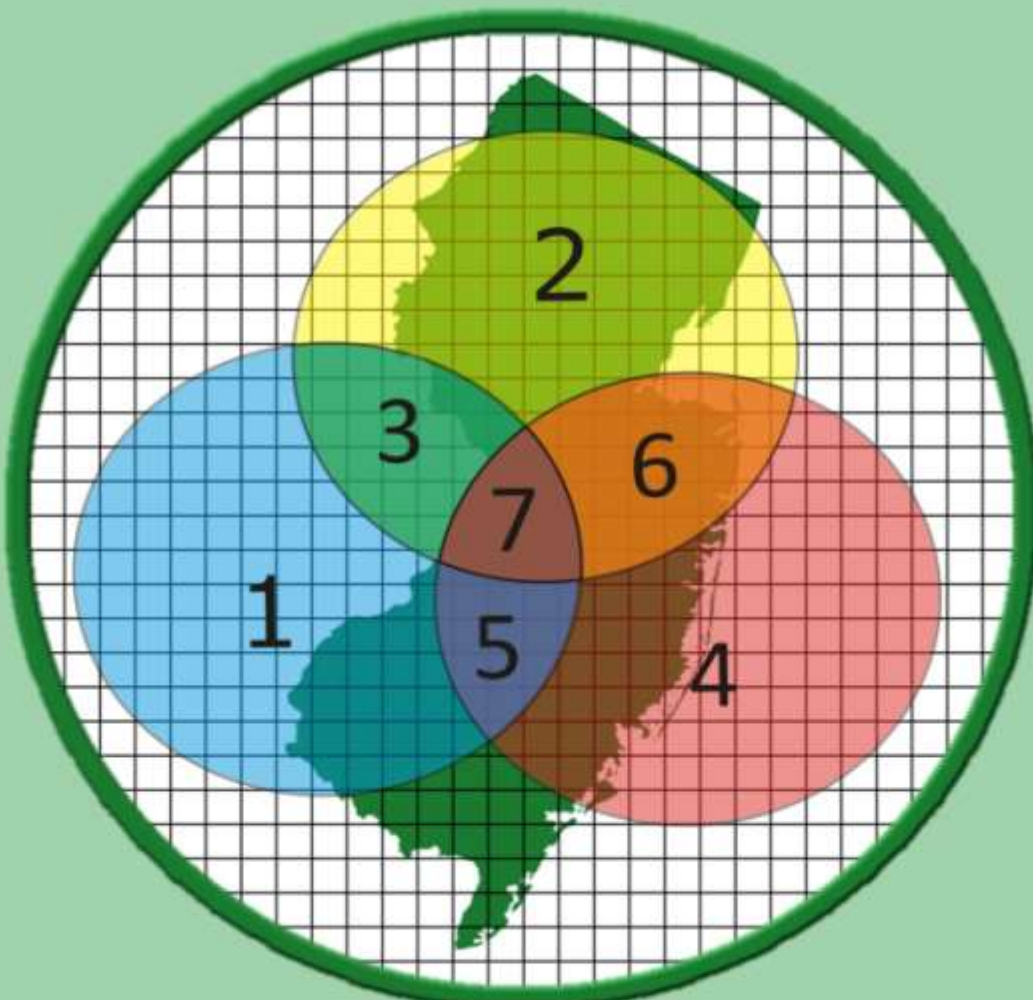
New Jersey Remedial Priority Scoring
Basis and Background
May 2012



New Jersey
Department of Environmental Protection
Site Remediation Program

New Jersey Department of Environmental Protection Site Remediation Program

Site Remediation Program

Remedial Priority Scoring: Basis and Background

May 2012
Version 1.0

ACKNOWLEDGMENTS

On May 24, 2010, SRP held a Public Hearing to describe the RPS model and the rationale behind its development. Following this hearing, SRP formed a Stakeholder Committee, which consisted of SRP personnel and non SRP personnel of varied backgrounds and perspectives, to review the methodologies, identify potential improvements, and to discuss future developments of the RPS System. Several subcommittees were formed to discuss model re-engineering. Each subcommittee reached a consensus and prepared a report of their findings and recommendations for the RPS model, which was submitted to the Site Remediation Program in March 2011. This collaborative effort enhanced the various components of the model, which has led to a more comprehensive system that more accurately represents the environmental characteristics of a site and its surroundings.

The latest version of the RPS has incorporated most of the recommendations of the Stakeholder Committee. The improved functionality of the RPS model would not have been possible without the collaborative efforts of the RPS Stakeholder Committee. Special thanks to all the Stakeholder Committees that assisted in the improvement of the RPS. Their valuable contributions have helped to guide the recent improvements.

The subcommittees are listed below:

GIS SUBCOMMITTEE

Name	Affiliation
DeFina, John	NJDEP SRP (retired)
Flanagan, Gregory	Sovereign Consulting, Inc.
Held, Joann	Air Toxics Analysis Services
Huber, William	Quantitative Decisions, Inc.
Maitin, Izak	NJDEP SRP (former)
Moore, Michael	NJDEP SRP
Norcross, Scott	URS Corporation
Reynolds, Kenneth	NJ Builders Association
Salazar, Ernie	Weston Solutions, Inc.
Towsey, David	The ELM Group

HAZSITE DATA SUBCOMMITTEE

Name	Affiliation
Alter, Benjamin	GZA GeoEnvironmental, Inc.
Cecan, Liliana	Interbrain LLC
Geary, Andy	NJDEP SRP
Kindervatter, Henry	NJDEP SRP
Lambert, Thomas	IMTT - Bayonne
Levinson, Matt	GEI Consultants
Liberman, Ken	SCIMED Consultants, LLC
McClellan, Bruce	North American Port Infra.
Toskos, Theodoros	Mactec Eng. & Consult.

ADDITIONAL DATA RESOURCES SUBCOMMITTEE

Name	Affiliation
Dougherty, William	Ground Water & Environmental Services, Inc
Houser, Trevan	Land Resource Solutions
Kloo, Karen	NJDEP SRP
Libourel, Jon	Brilliant Lewis Env., Servs.
Malaniak, Charles	Matrix New World Eng.
Messina, Frank	Exxon/Mobil Environmental Services
Meyer, Eric	Birdsall Services Group
Sodano, Nick	NJDEP SRP
Vanderslice, John	Environmental Alliance, Inc.

POLICY STAKEHOLDER SUBCOMITTEE

Name	Affiliation
Henry, Kelly	Ross Public Affairs Group
Russo, Tony	Site Remediation Industry Network
Restaino, David	Fox Rothschild
George-Cheniara, Elizabeth	NJ Builders Association
Bluhm, Sara	NJ Business and Industry Association
Pisauro, Michael	Michael L. Pisauro, Jr. LLC
Klein, George	NJDEP SRP (Chair)
Ricciardi, Karen	NJDEP SRP
Kloo, Karen	NJDEP SRP
Frasco, Barry	NJDEP SRP
Cramer, Donald	NJDEP SRP

EXECUTIVE SUMMARY

The New Jersey Department of Environmental Protection (NJDEP) Site Remediation Program (SRP) has developed a relative ranking, modeling system known as the Remedial Priority Scoring (RPS) System. The system is automated and uses established data sources. RPS was mandated pursuant to The Spill Compensation and Control Act (N.J.S.A. 58:10-23.16) as amended in section 39 of P.L. 2009, c.60 of the Site Remediation Reform Act (SRRA) which states "…NJDEP shall establish a ranking system that establishes categories in which to rank sites based upon the level of risk to the public health, safety, or the environment, the length of time the site has been undergoing remediation, the economic impact of the contaminated site on the municipality and on surrounding property, and any other factors deemed relevant by NJDEP." To accomplish this goal, the RPS model gathers data from different sources and creates a relative, categorical ranking for approximately 9,200 of SRP's active and pending contaminated sites. It is important to note that not all of the contaminated sites in New Jersey are included in the process. Some sites are excluded. The exclusions are post No Further Action (NFA) cases, homeowner cases and unknown source cases.

The general process of the RPS is to examine the area around the site for potential receptors; derive a Site Condition Score based on the contamination at the site; and determine the status of the pathway. The model utilizes multiple geographic databases and layers, receptor information and site-specific sampling data in determining a site score. More specifically, the final receptor score is determined by the proximity of receptors to the site. The final Site Condition Score is determined by the type and extent of contaminants present at the site. The pathway status of "open" or "closed" is determined and a pathway value of one or zero is assigned respectively. This process will be run for each applicable contaminated medium pathway at the site (i.e. ground water, soil, and vapor). Simply put, the RPS Score is equal to the Receptor Score multiplied by the Site Condition Score multiplied by a pathway value.

The advantage of the new RPS model is it applies a consistent, reproducible, approach using established and accepted data sources. It is designed to significantly minimize subjective human interpretations and anecdotal data inherent to more traditional ranking processes. Most

importantly, it provides a product that is otherwise impossible to achieve through a slower manual process. As with all models, the RPS model is only as good as the data provided.

As of May 2012, all sites (with some exceptions) will be required to be remediated with a Licensed Site Remediation Professional (LSRP). SRP has built the RPS model with this in mind. In addition, NJDEP is currently in the process of moving SRP sampling data into a new data repository. The new data repository and the associated reporting tools will make reporting on SRP chemical sampling data more accessible.

Existing Limitations

RPS is a model. It is intended to represent actions between site conditions, contaminant pathways and potential receptors. The model will calculate a relative categorization of contaminated sites that pose potential risk to human health and the environment. While the use of Geographic Information System (GIS) data and electronic sampling data are extremely powerful, it is also a new approach with few precedents at this scale. The Site Remediation Reform Act (SRRA), as amended on May 7, 2012, requires the submission of GIS-compatible data that represents the site boundary and all Area of Concern (AOC) boundaries. These delineations are critical to modeling actual conditions and modifying evaluation of potential impacts. It is also necessary that all data are accurate, complete and in a digital format. The data quality is crucial to the RPS model. As new analysis techniques are developed the quality of the model will improve. Finally, the model will improve when new spatial datasets representing the surrounding landscape and receptors are created and existing datasets are updated. In addition, the model itself continues to be improved with each version. These steps will enable SRP to produce an accurate, consistent RPS model and score. However, there will always be limitations. RPS is not intended to be a comprehensive site-specific risk model or replace site professionals. This model should be considered as one of the many tools that are useful when evaluating contaminated sites.

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Basis and Background

1. Background

The New Jersey Department of Environmental Protection (NJDEP), pursuant to N.J.S.A. 58:10-23.16 "Spill Compensation and Control Act" as amended in section 39 of P.L. 2009, c.60 "Site Remediation Reform Act," is directed to … "establish a ranking system that establishes categories in which to rank sites based upon the level of risk to the public health, safety, or the environment, the length of time the site has been undergoing remediation, the economic impact of the contaminated site on the municipality and on surrounding property, and any other factors deemed relevant by NJDEP." To comply with this requirement, NJDEP's Site Remediation Program (SRP) developed a relative ranking, modeling system known as the Remedial Priority Scoring (RPS) System. The system is automated and uses established data sources to create a relative ranking score for approximately 9,200 of the SRP active and pending contaminated cases.

1.1. RPS Overview

The general design of the RPS model follows the NJDEP Contaminant, Pathway and Receptor (CPR) Analysis of Risk Methodology to determine the potential risk of a site. This Methodology provides a conceptual model for NJDEP to evaluate how contamination may migrate from a site and potentially cause harm to a receptor. The RPS model separately evaluates the contamination attributed to the site, the potential pathways for the contamination, and the potential receptors near the site and then combines the results into a final category.

1.1.1. Contaminant

NJDEP has developed a methodology to characterize the relative level of contamination at a site with a single value. This value is referred to as the Site Condition Score. In order to compare sampling results across time and space, the concentration of contaminants in samples are normalized based on the contaminant properties. Section 3.2 in this document describes the process to calculate a Site Condition Score in detail. The contaminant concentrations that are submitted to NJDEP as part of an Electronic Data Deliverable (EDD) are used to calculate the Site Condition Score. The SRP stores the EDDs in a data repository that is called HazSite. To estimate the extent of contamination at a site, SRP establishes an Extent Area for each medium. The Extent Area is used by the RPS Model to evaluate the potential impact on receptors near a site

1.1.2. Pathway

The contaminant pathway is the route that a hazardous substance can take to expose a person or adversely affect an environmental system. The RPS model uses a binary toggle to characterize the contaminant pathway. If contamination has been appropriately delineated and no receptors have been identified (or all have been abated), then the pathway has been determined to be "closed." A closed pathway is assigned a score of 0. All other pathways are assumed to be "open" and are assigned a 1. The Pathway Score is multiplied by the Receptor Score and Site Condition Scores to calculate the final score. The pathways are evaluated based on Receptor Evaluation forms that have been submitted to SRP.

1.1.3. Receptor

The potential receptors near a site are derived by using Geographic Information Systems (GIS) layers. All relevant information that is available to NJDEP is incorporated into creating GIS Receptor layers. When possible, the values in the Receptor layers are based on the potential population at risk near the site and exposure duration. If the population cannot be ascertained from existing GIS layers, surrogate values are used that are scaled proportionally to those layers that are based on population. Currently, the RPS Model has two distinct classes of receptors: Human Health Receptor Class and the Ecological Health Receptor Class. The two Receptor Classes are examined and scored separately. The RPS Model has been designed to allow adding new Receptor Classes as needed (i.e., Economic Impact).

1.2. Pathway and Modes of Exposure

The RPS model evaluates potential risks based on the potential modes of exposure and a mode of exposure is considered a unique combination of exposure method and pathway that could bring the contaminants into contact with a receptor. The exposures considered are ingestion, dermal and inhalation and the pathways are soil, ground water, surface water, vapors, and sediments. The Sediment Pathway was not included in this version of the RPS Model. GIS layers were developed to characterize these potential modes of exposure. For the Human Health Class, the evaluation of the contaminant, pathway and potential receptors are performed for each medium and then combined to generate a final Human Health Score. Only the ground water pathway is used to evaluate the Ecological Health Score.

1.3. NJDEP Sites included in the RPS Model

The sites evaluated by the RPS Model are generated from the "Active Sites with Confirmed Contamination" and "Pending Sites with Confirmed Contamination" reports, which are two of SRP's "Known Contaminated Sites in New Jersey Reports" (KCSNJ). NJDEP uses two Databases Systems to generate the KCSNJ. The databases are Masterfile and the New Jersey Environmental Management System (NJEMS). Additional information regarding the KCSNJ can be found on the "Known Contaminated Sites in New Jersey Reports" web site, which is located at http://www.nj.gov/dep/srp/kcsnj/. Figure 1-1 shows the KCSNJ sites in southeast Passaic County NJ as shown on NJ GeoWeb. Sites that are on the "Closed Sites with Remediated Contamination" Report are not included in the RPS Model. Landfills that are not under the review / oversight of SRP also are not included in the KCSNJ RPS Model.

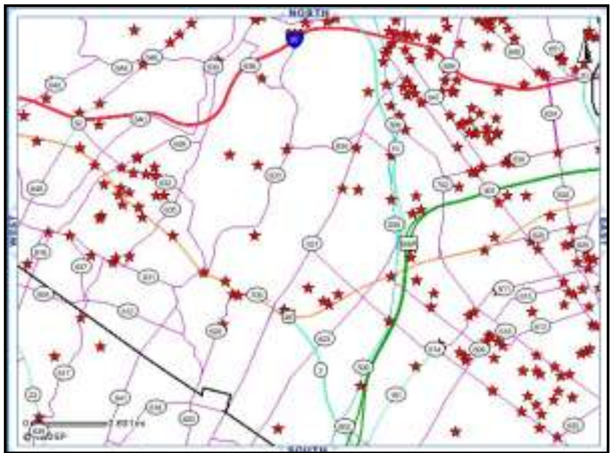


Figure 1-1 – KCS sites in southwest Passaic County.

RPS Exclusions - It is important to note that not all of the contaminated cases in the active / pending KCSNJ are included in the final RPS Ranking. The excluded cases are:

- Post No Further Action (NFA) Monitoring Cases - Post NFA cases that have been issued a restricted or limited restricted NFA for the case. These cases have a Classification Exception Area and/or Deed Notice established as an institutional control for the identified contamination. The RPS excludes these cases because the remediation has been implemented, there are no further impacts to receptors and the residual contamination is being monitored by either a Biennial Certification Report or a Remedial Action Permit. The entire site is excluded if the only type of case at the site is post NFA Monitoring.

- Homeowner Cases - Residential properties (single family and multi-dwelling units of 4 or less) that utilize unregulated underground storage tanks with a capacity of 2,000 gallons or less to heat residential buildings. These sites are not included on the RPS list because they are generally considered to be of lower risk and any contamination will be remediated prior to NJDEP involvement.
- Unknown Source - Cases with this designation have been identified as having ground water contamination, but the source of the contamination is unknown. Unknown source sites that pose an immediate threat to human health are assigned to SRP staff to oversee or to take remedial action to prevent human exposure to the hazardous substances found. Possible remedial actions to ensure the availability of a potable water supply include providing an alternate water supply or treating the affected water supply. These sites are not included on the RPS list because the source of the contamination is unknown and in all known cases the receptors are being addressed via SRP oversight.

1.4. Flags

The RPS model evaluates the contamination at the site and potential receptors at risk; however, there are other issues not evaluated by the RPS model that are identified. These issues are designated as “flags” and provide additional information related to the site. Several flags identify specific chemicals, which are mandated by SRRA (chromate, polychlorinated biphenyl, mercury, arsenic and dioxin). Other flags identifying specific conditions at a site such as Immediate Environmental Concern (IEC), compliance, etc., which helps to represent site specific attributes and assist SRP in implementing the Licensed Site Remediation Program (LSRP) program.

2. General Model Design

The fundamental principle of the RPS Model is to estimate the potential risk of a site; however, the RPS is not a full site risk assessment. The Model input is based on information that is being electronically submitted to and/or collected by NJDEP. The advantage of using an automated, data driven, computerized system is that it applies a consistent, reproducible approach using established and accepted data sources. It is designed to significantly minimize subjective human interpretations and anecdotal data inherent to more traditional ranking systems. Most importantly, it provides a product that is otherwise impossible to achieve through a manual process. As with all models, the RPS Model is only as good as the data provided.

Sites are ranked based on how much of a chemical is present in an environmental medium, the potential exposure of a person or ecological receptor to the contaminated environmental medium, and the chemical's inherent toxicity. The RPS Model employs SRP's CPR Analysis of Risk Methodology to ascertain the potential risk of the site. The contaminant, pathway and potential receptors are evaluated separately and then combined to generate a final RPS Score for each medium.

2.1. Model Process

The model utilizes multiple geo-referenced databases and layers, receptor information and site-specific sampling data in determining a category for a site. The RPS Model is run in several phases to combine all of this information into a final score. The first is the creation of GIS Receptor layers that cover the entire State. Once the GIS Receptor layers are created, the input values for the RPS model can be calculated. The steps used to create the input values for the RPS model are 1] calculation of a Site Condition Score, 2] assignment of a Pathway Score, and 3] creation of three Extent Areas for each site (water, soil and vapor) and then using these Extent Areas to calculate a Receptor Score for each site. The RPS Model uses these input values to calculate a Final Human Health and Ecological Health Receptor Score. The final step is to rank the sites into categories using Jenks' Natural Breaks, which is a data classification methodology (see Section 5, Final RPS Categories).

2.1.1. Creation of GIS Receptor Layer

GIS Receptor layers are created for the entire State using 100- by 100-foot grids. Values are assigned to each cell based on potential receptors within that grid cell. For the Human Health Receptor Class, GIS Receptor layers were created for potential modes of exposure identified for each medium (water, soil and vapor). The Receptor layers have been created by NJDEP incorporating information that best represents potential receptors. The population at risk is estimated by adapting several sources, such as census data, land use coverage and NJDEP's

Division of Water Supply information. Appendix A of this document outlines the development process for the GIS layers. The layers will be updated on a periodic basis, as needed. These layers will also be used to generate a Receptor Score for new sites not on the KCSNJ at this time.

2.1.2. Model Inputs

The input values for the RPS model are the Site Condition Score, Pathway Score, and Receptor Score for each medium at the site.

- **Site Condition Score**: The Site Condition Score is calculated for each medium and represents the contamination at the site. The Score is calculated from the Electronic data that have been received by SRP (see section 3.2 for more details).
- **Pathway Score:** A Pathway Score is calculated for each Medium. The pathway score is based on the Receptor Evaluation conducted at the site and reported to SRP on a Receptor Evaluation Form. A Pathway Score of 0 is assigned to a closed pathway; all others are assigned a 1 (see section 3.3 for more details).
- **Receptor Score:** To Calculate a Receptor Score, the Extent Area, which is an estimate of the contamination at the site, is created for the three media. The GIS Receptor layers are overlain by the appropriate Extent Area and then a Receptor Score is calculated for each Receptor layer. The Score is based on the intersection of the Extent Area and Receptor layer. The Extent Area can be thought of as a "cookie cutter" that cuts out the cell values from the GIS Receptor layers. The cell values within the cutout area are used to calculate the Receptor Score. The Receptor Scores are then summed by medium (see section 3.4 for more details).

2.1.3. Calculate Receptor Class Scores

Once all of the input values have been generated, a final Score can be calculated for the Human Health Class and the Ecological Health Class.

- **Human Health Receptor Class:** A final Medium Score is calculated for water, soil and vapor by multiplying the Receptor Score by the Site Condition Score by the Pathway Score. The final Medium Scores are summed to calculate the final Human Health Score.

- **Ecological Health Receptor Class**: The Ecological Health Score is calculated by multiplying the Ecological Receptor Score by the Pathway Score.

2.1.4. Ranking Sites

A RPS Category is established to describe the cumulative risk posed by each site for both the final Human Health and Ecological Health Scores. The RPS Model uses the "Jenks Natural Breaks" function within the ArcGIS® 10 software from Environmental Systems Research Institute (ESRI) to rank the sites into 5 Categories. ArcGIS® refers to these Categories as Classes. The help section in ArcGIS® 10 states that "Classes are based on natural groupings of data values. In this method, data values are arranged in order. The class breaks are determined statistically by finding adjacent feature pairs, between which there is a relatively large difference in data values." The Jenks Natural Breaks used in ArcGIS® 10 is based on the Jenks' Natural Breaks algorithm. Category 1 includes sites with the lowest RPS scores and Category 5 includes sites with the highest RPS scores.

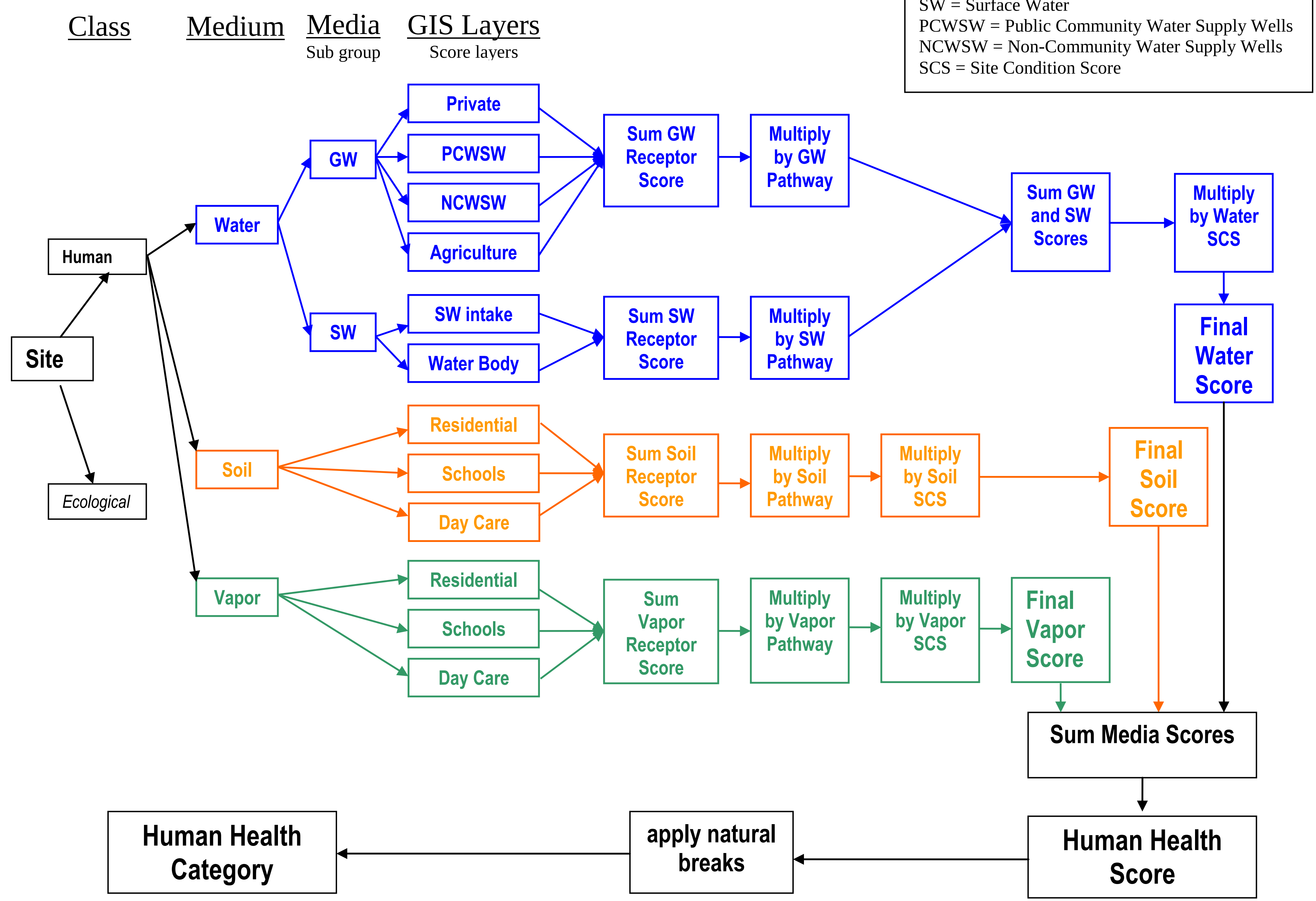
Figure 2-1 and figure 2-2 graphically depict the overall process used to calculate a final Human Health Receptor Score and Ecological Health Receptor Score, respectfully.

3. RPS Model Data Sources / Model Inputs

As mentioned above, the RPS process gathers data from several different sources and creates a relative ranking score for the SRP contaminated sites. The RPS model utilizes various geo-referenced databases and layers that characterize the potential receptors near the site and surrounding area, site-specific analytical sampling data, and other relevant available data. This information is needed to accurately reflect site conditions, potential contaminant pathways and potential receptors near these sites. As a result, the model has three main data sources:

- HazSite Sampling Data
- NJEMS / Masterfile Data
- GIS Layers

Figure 2-1. Model Diagram for the Human Health Receptor Class



Human Health Receptor Class Notes:

The RPS consists of two Classes: Human and Ecological

Human Class

a) The Human Health Class is subdivided into three media (water, soil and vapor)

- The Water Medium consists of ground water and surface water

  GIS layers have been created for potential exposure pathways for each medium identified:

  1. Ground Water:
     - i. Private: based on private domestic wells
     - ii. Public Community Water Supply Wells (PCWSW): based on well head protection areas for PCWSW
     - iii. Non-Community Water Supply Wells (NCWSW): based on well head protection areas for NCWSW
     - iv. Agricultural: based on agricultural land use
  2. Surface Water (SW):
     - i. Surface Water (SW) Intake: based on SW sources of potable water
     - ii. Water Body (Human Health): based on Surface Water Quality Standards designation and stream usage
  3. Soil:
     - i. Residential: based on potential exposure of nearby residential populations
     - ii. Schools: based on potential exposure of nearby schools
     - iii. Day Care: based on potential exposure of day care facilities
  4. Vapor:
     - i. Residential: based on potential exposure of nearby residential populations
     - ii. Schools: based on potential exposure of nearby schools
     - iii. Day Care: based on potential exposure of day care facilities

b) **GIS Layers:** Receptors scores were generated for all GIS layers based on the Extent Areas for each site

c) **Sum Receptor Scores:** The individual Medium Receptor Scores are summed by Medium (Water Medium is summed by sub-group)

d) **Pathway Calculation:** The Medium Receptor Scores are multiplied by the appropriate pathway scores

- **For Water Medium:** The Ground Water (GW) Score and SW Score are summed for one water score

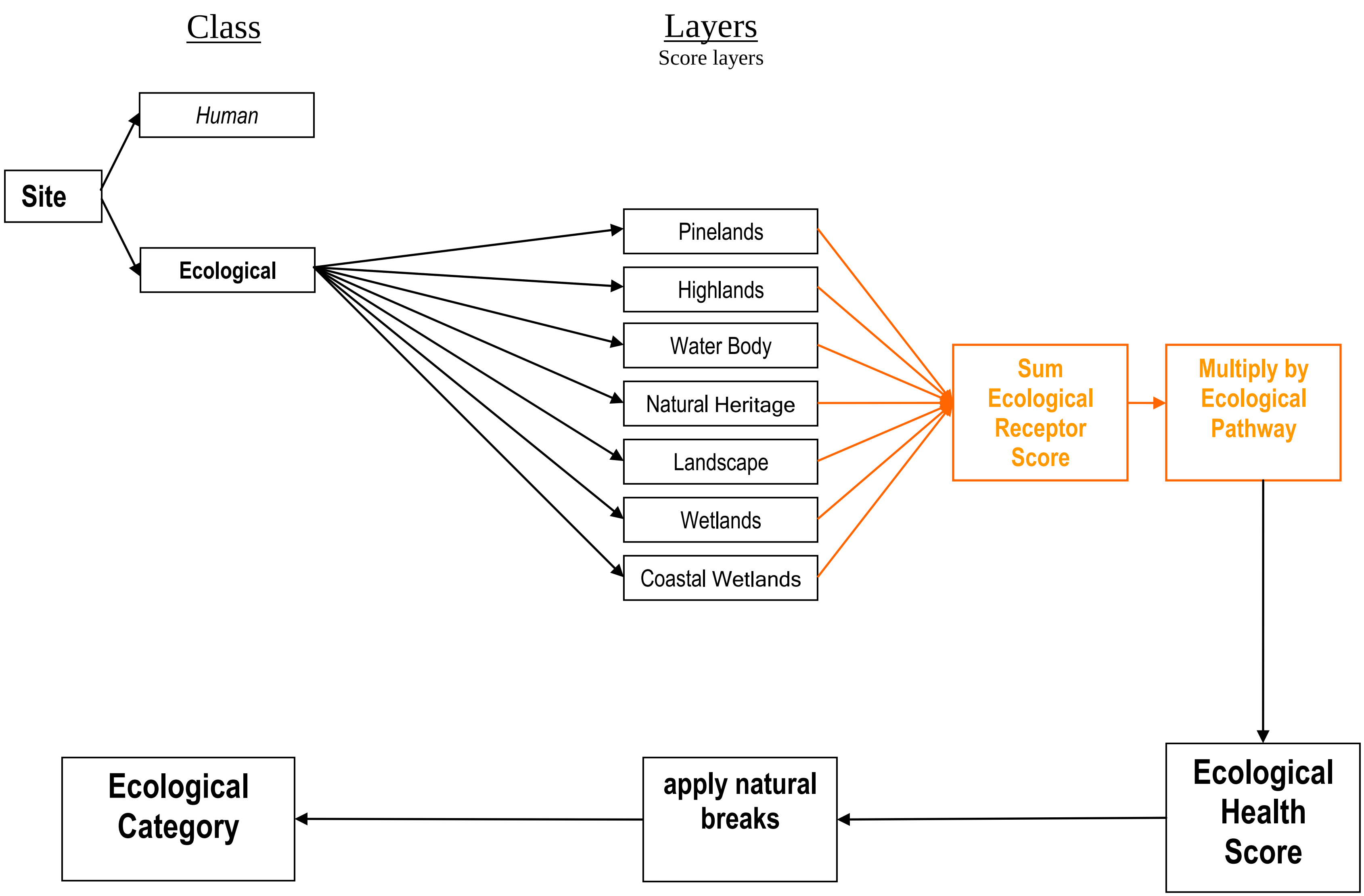
e) **Site Condition Score:** The Water, Soil and Vapor Results from d. above are multiplied by the Water, Soil and Vapor Site Condition Score (SCS), respectfully to produce the Final score for each Medium.

f) **Final Human Health Score:** The Final Water, Soil and Vapor Medium Scores are summed to produce the final Human Health Score.

g) **Natural (Jenks') breaks:** The final Human Health Score is divided into 5 categories using a natural breaks method.

h) **RPS Human Health Category:** Sites are assigned an RPS Human Health Category based on the Natural Breaks established in g, above

Figure 2-2. Model Diagram for the Ecological Receptor Class



Ecological Receptor Class Notes:

The RPS consists of two Classes: Human and Ecological

Ecological Class

a) **GIS Layers**: GIS layers have been created the following for Ecological Receptors
   1) Pinelands
   2) Highlands
   3) Water Body (Ecological)
   4) Natural Heritage
   5) Landscape
   6) Wetlands
   7) Coastal Wetlands

b) Receptors scores were generated for all GIS layers based on the Ground Water Extent Areas for each site.

c) All of the Ecological Receptor layers were summed.

d) **Pathway Calculation:** The Ecological Receptor Score is multiplied by the Ecological Pathway Score

e) **Final Ecological Health Score:** The value generated in d, above, is the Ecological Health Score

f) **Natural (Jenks') breaks:** The Ecological Health Score is divided into five categories using a natural breaks method.

g) **RPS Ecological Health Category:** Sites are assigned an RPS Ecological Health Category based on the Natural Breaks established in f, above

3.1. Known Contaminated Sites in New Jersey Reports (NJEMS / Master File)

NJDEP uses NJEMS and Master File databases to store all information for the site and track the administrative progress of each case. The list of sites to be ranked is created from SRP's KCSNJ report as outlined in 1.3 above. Table 3-1 lists the selected non-spatial data fields stored in NJEMS and Master File that the RPS uses to refine the KCSNJ list.

Table 3-1. NJEMS SRP Information

Field Name	Field Use
Activity Class	Activity Class assists in the identification of the assigned Bureau and the Case Type
Activity Type	Activity Type is used to identify the remedial phase of a case, which is used to determine RPS Exemptions and assignment of surrogate values
Block / Lot	Block / Lot are the tax parcels identified at the site level, which is used to create the surrogate Soil Extent Area when available
Bureau	Bureau is used to assign surrogate values for the Extent Area and Site Condition Score
Case Status	Case Status is used to identify what cases are active, pending or closed
Case Tracking Number	Case Tracking Number is the unique identifier that SRP uses to track the details of each case
Case Type	Case Type is used to identify what cases are not scored (i.e. homeowner)
IEC	IEC is an Immediate Environmental Concern and is used to generate an RPS Flag
GW_Flow	GW_Flow is the predominant ground water flow direction identified by ground water monitoring at the site and used to create the elliptical surrogate Ground Water Extent Area when available
PI X-Coordinate	PI X-Coordinate is the Easting component of the site's location in NJEMS and is used to establish the surrogate Extent Areas
PI Y-Coordinate	PI Y-Coordinate is the Northing component of the site's location in NJEMS and is used to establish the surrogate Extent Areas
Preferred ID	Preferred ID is a unique identifier used to identify a program interest
Remedial Level	Remedial Level represents the complexity of a site based on the medium affected and the source of contamination and is used to identify the soil remediation only cases
Site ID	Site ID is a unique identifier that is used to identify sites

3.2. Site Condition Score (HazSite Sampling Data)

The Site Condition Score, which is a single value that characterizes the relative risk of contamination at a site, is calculated from the EDD sampling data that were submitted to NJDEP and stored in HazSite[1]. HazSite represents the most comprehensive source of sampling data available to SRP at this time. The electronic data are submitted to SRP electronically in three files. They are as follows:

- DTST – includes basic information about the submittal
- HZSAMPLE – includes information about the samples, such as sample date, sample designation, sample matrix, sample location, well elevation and more
- HZRESULT – includes information generated by the laboratory that includes chemical name, CAS#, analyte name, concentration, analytical method and more

Calculate Site Condition Score

The RPS Model uses HazSite data to characterize the level of contamination at the site. At this time, only the soil, ground water and potable well sampling results are used. The RPS Model compares contaminants with different properties and different concentrations across distance and time through normalization of the sampling results based on the properties of the contaminants. Since the concentration of a contaminant alone does not accurately reflect the magnitude of risk posed by differing contaminants, a normalized value is calculated for each analyte, which is called the Exceedance Quotient (EQ). The normalized values are used to generate a Site Condition Score. There is a Site Condition Score calculated for each medium: ground water, soil, and vapor intrusion.

The use of HazSite data to generate a Site Condition Score places a significant weight on the quality of data. As a result, close review and analysis of the HazSite data has taken place. The most obvious data problem identified is that approximately 50% of the cases have no HazSite data. A default value is automatically given to a case without HazSite data, which is equal to the 75th percentile of the data range for that Bureau (for more details, see section 3.2.1.5). When more sampling data are submitted to NJDEP and included in HazSite, the reliability of the RPS Scoring will improve.

3.2.1. Ground Water Site Condition Score

[1] More information regarding the HazSite data and the definitions for all data fields are located in the "SRP Electronic Data Interchange (EDI) Manual" at **http://www.nj.gov/dep/srp/hazsite/docs/**.

The concentration of a contaminant is normalized based on the specific ground water contaminant. Not all ground water results are used. The RPS Model limits the sampling results to only recent sampling events and does not consider those contaminants without a health-based standard. A Ground Water Site Condition Score is not calculated if the case does not have a ground water trigger.

3.2.1.1. Sampling data used to calculate the Ground Water Site Condition Score

The ground water sampling results used to calculate the Ground Water Site Condition Score are from HazSite. The RPS Ground Water Sampling Population is the latest sampling round and all other sampling events within 900 days prior to that sampling event (figure 3-1). This is done to limit the number of sampling events and ensure that only recent samples are being considered. If quarterly monitoring has been performed, the RPS would evaluate approximately 10 sampling rounds. Only those results that are over the Ground Water Quality Standards (GWQS) are used to calculate the Ground Water Site Condition Score with one exception. If an analyte exceeds the GWQS, then all of the results for that analyte for the same well are included in the calculation. For example, if the Benzene concentration from MW-1 exceeded the GWQS during for any of the RPS ground water sampling population, then all of the Benzene results from MW-1 would be used in the calculation regardless of the analyte's concentration.

Figure 3-1. Process to determine the Ground Water Sampling Population used to calculate the GW Site Condition Score.

- Example: Last Sample Round was 1/20/2010

8/4/2007 ——— *900 days* ——— 1/20/2010

- Any sampling data between 8/4/2007 and 1/20/2010 would be used in RPS Model

3.2.1.2. Criteria used to normalize ground water sampling data

The following variables are used to normalize the initial analyte concentration for all results that exceed the GWQS. The initial concentration is modified by each of the following factors, when applicable. Each factor is taken into account individually and then used as input for the next calculation.

- **Solubility**

The solubility is taken into consideration because it represents the maximum concentration of an analyte in the water phase (EPA, 1995).

> ➢ If the ground water concentration is greater than the solubility, then the solubility is substituted for the concentration.

- **Human Health-based Criteria**

The Ground Water Quality Criteria (GWQC) for Class IIA ground water are used to modify the value, because it is based on the Risk to Human Health (NJDEP, 2011b). This allows the RPS model to compare analytes with different Human Health Risks.

> ➢ The modified value is divided by the GWQC for Class IIA ground water that are established in the GWQS (N.J.A.C. 7:9C) as of April 2012.

- **Mobility / Retardation**

Mobility is represented in the RPS Model by the Retardation Factor (R). The Retardation Factor is equal to 1+ (K_{oc}*f_{oc}* ρ /n_e) for organics and 1+ (K_{oc}* ρ /n_e) for inorganics (Freeze and Cherry, 1979). Default variables based on a typical New Jersey site are used to calculate a Retardation Factor for all analytes (see Table 3-2 for the default values). Mobility is considered because this is one of the factors that control contaminant migration. Analytes with a Retardation Factor greater than or equal to 2 are thought to be less mobile and the concentration is decreased accordingly.

> ➢ If R is greater than or equal to 2, the value is divided by 2, otherwise it does not change.

Table 3-2. Default values used in Exceedance Quotient calculation

	Variable	Value
f_{oc}	Fraction of Organic Carbon	0.0002
ρ	Bulk Density	1.5
n_e	Porosity	0.3
K_{oc}	organic carbon/water partition coefficient	*

* = The value is determined by the contaminant

- **Degradation / Half-Life**

Degradation is represented in the RPS Model by the analytes' half-life ($t_{½}$). This is considered because it is one factor that controls contaminant migration (Freeze and Cherry, 1979). Analytes with a half-life less than or equal to 2 are thought to be less persistent and the concentration is decreased accordingly.

  - If $t_{½}$ is less than or equal to 2, the modified value is divided by 2, otherwise it does not change.

- **First-order attenuation rate constant**

Natural Attenuation processes reduce the contaminant concentration both spatially (away from the source) and temporally. It includes a wide variety of physical, chemical and biological processes with the main processes being dispersion and biodegradation. The concentration variations have been shown to follow a first order rate constant (USEPA, 2002). In addition, the evaluation of the HazSite data for several sites also implied a log-normal distribution.

  - The natural log is taken of the modified value

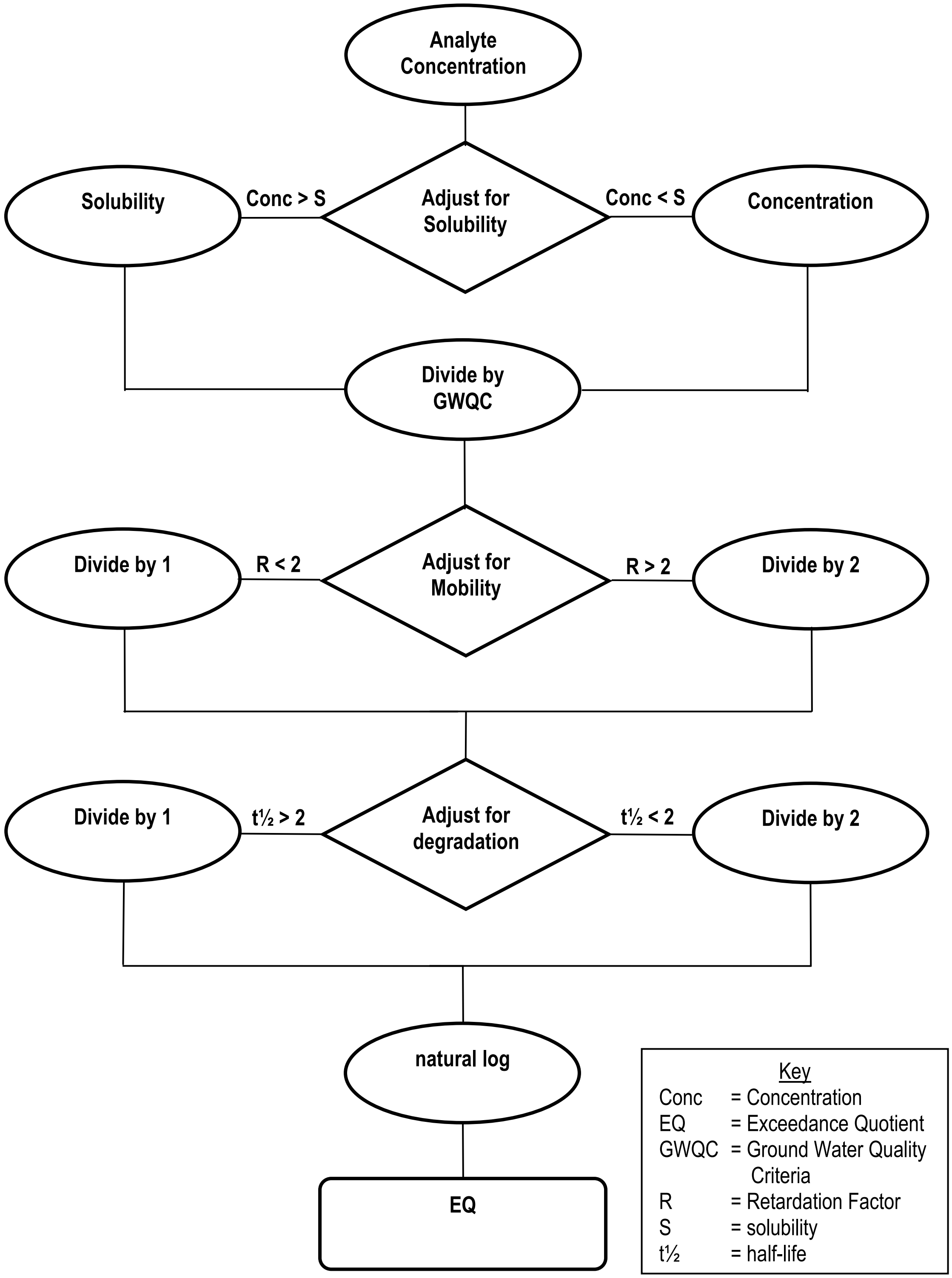
3.2.1.3. Ground Water Exceedance Quotient

The Exceedance Quotient is the resultant value generated by the normalization process. Only one value is calculated for each analyte. Figure 3-2 represents the ground water normalization process. The Exceedance Quotients are used to generate a Ground Water Site Condition Score.

3.2.1.4. Final calculation for the Ground Water Site Condition Score

The RPS Model employs a two-tailed Student's t-test (Appendix B) to compute the 95% upper confidence limit (UCL) for all of the Exceedance Quotient values (Mendenhall, 1975). This final value is the Ground Water Site Condition Score. The Ground Water Site Condition Score is used to generate the Ground Water Medium Score. If the sample population is less than 4, then the Ground Water Site Condition Score is the average of the Exceedance Quotients and not the 95% UCL.

Figure 3-2. Steps used in the Exceedance Quotient normalization process for Ground Water Media.



3.2.1.5. Cases Missing HazSite Data

If HazSite ground water data are not available for the site, then a surrogate value is used. The value is based on the Bureau the case was assigned to prior to the LSRP program. The default Ground Water Site Condition Scores are listed in Table 3-3. If the case is in the RI phase, the surrogate Site Condition Score is equal to the Default High value (75^{th} percentile of the range of scores for that Bureau). If the case is in the PA or SI phase, the Default Low value is used (25^{th} percentile).

Table 3-3. Surrogate Ground Water Site Condition Score by Bureau

Bureau	Full Bureau Name	GW Site Condition Score Default High	GW Site Condition Score Default Low
BCM	Bureau of Case Management	1.900	0.533
BER	Bureau of Emergency Response	2.016	0.4
BFO-N	Bureau of Northern Field Operations	2.222	0.182
BFO-S	Bureau of Southern Field Operations	2.448	0.518
BIDC	Bureau of Investigation Design & Construction	1.837	0.253
BISR	Bureau of Industrial Site Remediation	2.380	0.588
BOMM	Bureau of Operation, Maintenance & Monitoring	2.138	0.178
BUST	Bureau of Underground Storage Tanks	2.270	0.234
CAS	Case Assignment Section	2.556	0.093
OBR	Office of Brownfield Reuse	0.976	-
OWR	Office of Wellfield Remediation	0.634	0.001
RPIU	Responsible Party Investigation Unit	2.016	0.400
SA	Site Assessment	2.016	0.400
All other Bureaus	All Bureaus not listed above	2.016	0.400

3.2.2. Soils Site Condition Score

The RPS Model evaluates all soil sampling results; however, only those analytes that exceed the most stringent health based Direct Contact Soil Remediation Standards are normalized based on the specific contaminant.

3.2.2.1. Sampling data used to calculate the Site Condition Score

The soil sampling results used to calculate the Site Condition Score are stored in HazSite. All of the soil sampling events in HazSite are included in the RPS Soil Sampling Population, which is used to calculate the Site Condition Score. All of the sampling events are used because sampling points are not required to be periodically re-sampled as with ground water monitoring wells; however, only sampling results that are above the Direct Contact Soil Remediation Standards are used as input into the RPS Model. Those contaminants without a health-based standard are omitted.

3.2.2.2. Criteria used to normalize the sampling data

The following variables are used to normalize the initial analyte concentration for all results that exceed the Direct Contact Soil Remediation Standards. The initial concentration is modified by each of the following factors. The RPS Model takes into account each factor individually and then uses the result in the next calculation.

- **Soil Exposure Potential (Sample Depth)**

  Adjustments to the initial concentrations are made based on soil exposure pathways. The pathways are dermal, ingestion and inhalation. To evaluate the potential for exposure, the RPS Model groups the soil samples based on exposure potential. Contamination in "Surface Soils" (the top 2 feet of the soil column) is grouped together because surface soils have the greatest chance for exposure. Soils between 2 and 10 feet are grouped together and named "Subsurface Soils" because exposure of these soils would require excavation. The depth is an estimate of the average excavation that might occur during normal construction. Soil depths greater than 10 feet are called "Deep Soils". Exposure of these soils would require extreme excavations. In order to consider the potential risk of exposure, the RPS Model uses a Soil Qualifier to adjust the sample concentration in these three zones. The Soil Qualifiers are listed in Table 3-4.

- The concentration of each contaminant is **divided by** the Soil Qualifier to obtain the adjusted concentration.

Table 3-4. Soil Qualifiers used to normalize Site Condition Score based on contamination depth		
Soil Group	**Soil Depth**	**Soil Qualifier (divide by)**
Surface Soils	0 – 2 feet	1
Subsurface Soils	Between 2 & 10 feet	5
Deep Soils	> 10 feet	10

- **Human Health-based Criteria**

The most stringent Direct Contact Soil Remediation Standard is used to modify the value because it is based on the Risk to Human Health (NJDEP, 2011a). The standards used for soils are the Soil Remediation Standards as found in the Remediation Standards (N.J.A.C. 7:26D). This allows the RPS model to compare analytes with different Human Health Risks.

- The modified value is divided by the Direct Contact Soil Remediation Standards that are established in the Remediation Standards (N.J.A.C. 7:26D) as of April 2012.

- **First-order attenuation rate constant**

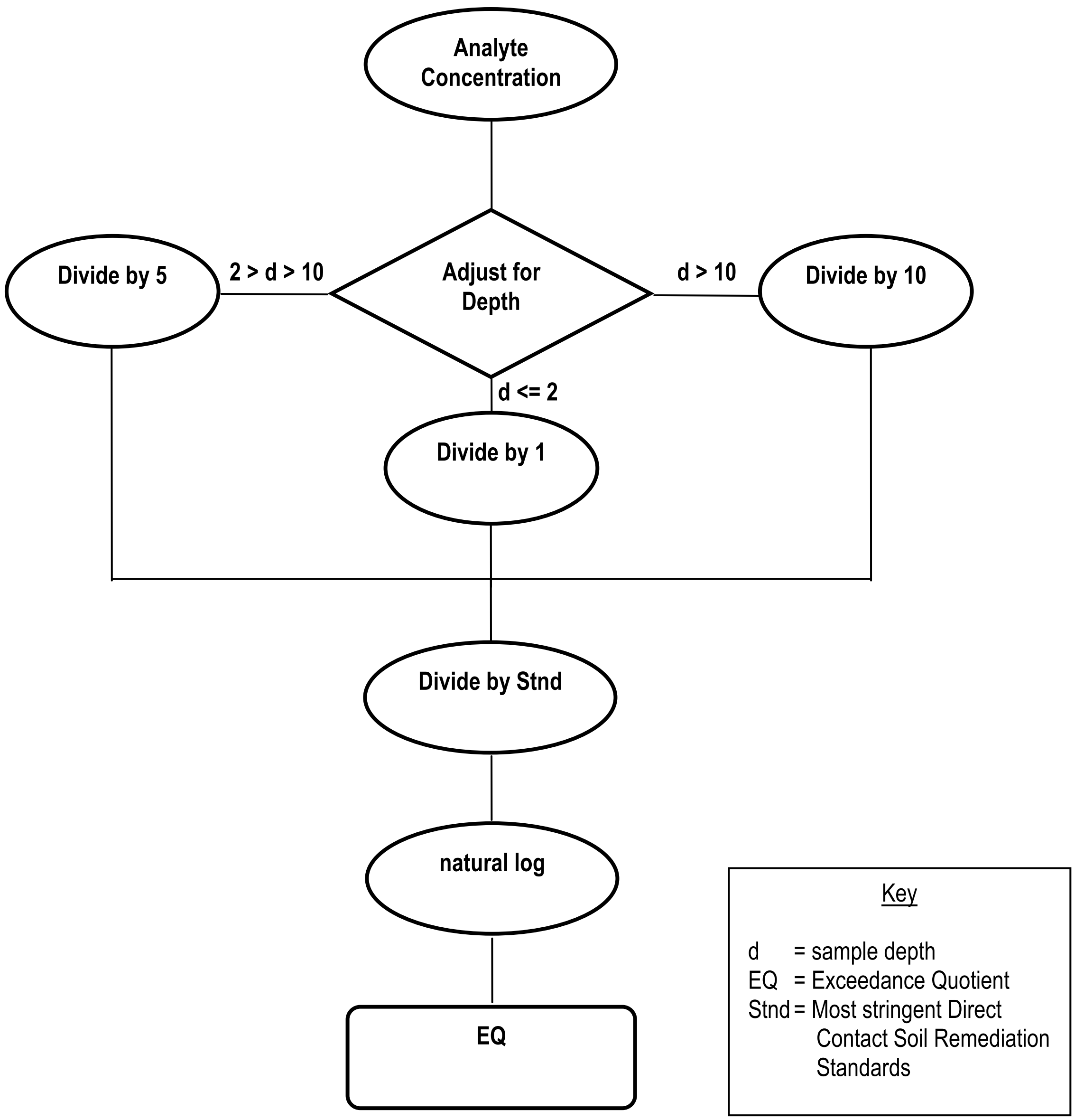
Natural Attenuation processes reduce the contaminant concentration both spatially (vertically through the soil column) and temporally. The processes include a wide variety of physical, chemical and biological processes. The concentration variations have been shown to follow a first order rate constant (USEPA, 2002). In evaluating the distribution of the HazSite data, the concentrations for each site implied a log normal distribution. To normalize the data based on natural attenuation, the natural log is taken.

- The natural log is taken of the modified value

3.2.2.3. Soil Exceedance Quotient

The Exceedance Quotient is the value that is calculated during the normalization process. Only one value is calculated for each analyte. Figure 3-3 represents the soil normalization process. The Exceedance Quotients are used to generate the Soil Site Condition Score.

Figure 3-3. Steps used in the Exceedance Quotient normalization process for Soil Media.



3.2.2.4. Final calculation for the Soil Site Condition Score

The RPS Model employs a two-tailed Student's t-test (Appendix B) to compute the 95% UCL for all of the soil Exceedance Quotient values (Mendenhall, 1975). This final value is the Soil Site Condition Score. The Soil Site Condition Score is used to generate the Soil Medium Score. If the sample population is less than 4, then the Soil Site Condition Score is the mean of the Exceedance Quotients and not the 95% UCL.

3.2.2.5. Cases Missing HazSite Data

If HazSite soil data are not available, then the RPS uses a surrogate value. The value is based on the 75th percentile of the site range of scores from the Bureau the case was assigned to prior to the LSRP program. Table 3-5 shows the default values for the surrogate Soil Site Condition Score.

Table 3-5. Surrogate Soil Site Condition Score by Bureau

Bureau	Soil Site Condition Score Default
BCM	1.959
BER	1.742
BFO-N	1.888
BFO-S	2.313
BIDC	1.882
BISR	2.105
BOMM	1.861
BUST	0.88
CAS	2.121
OBR	1.83
OWR	3.023
RPIU	0.001
Site Assessment	0.001
All other Bureaus	1.742

3.2.3. Vapor Site Condition Score

The ground water results are used to characterize the potential risk of vapor intrusion at a site as outlined in the SRP “Vapor Intrusion Technical Guidance” document. The ground water sampling results are normalized based on the specific contaminant. Not all ground water results are used. Sampling results used in the RPS Model are limited to recent sampling events. Contaminants without an Indoor Air Screening Level cannot be considered for scoring purposes.

3.2.3.1. Sampling data used to calculate the Site Condition Score

The ground water sampling results used to calculate the Vapor Site Condition Score are stored in HazSite. The RPS Ground Water Sampling Population used to calculate the Vapor Score is the latest sampling round and all other sampling events within 900 days prior to that sampling event. This is done to limit the number of sampling events and ensure that only recent samples are being considered by the RPS. Only sampling data above the Ground Water Screening Level are used as input into the RPS Model. A Vapor Site Condition Score will not be created for those sites that do not have any ground water sampling results that exceed the Ground Water Screening Level. Cases that do not have HazSite results are assumed to have a vapor trigger and are assigned a surrogate Vapor Site Condition Score.

3.2.3.2. Criteria used to normalize the sampling data

The following variables are used to normalize the initial analyte concentration for all results that exceed the Ground Water Screening Level. The initial concentration is modified by each of the following factors when applicable. Each factor is taken into account individually and then used in the next calculation.

- **Solubility**

  The solubility is taken into consideration because it represents the maximum concentration of an analyte in the water phase (EPA, 1995).

  - If the ground water concentration is greater than the solubility, then the solubility is substituted for the concentration.

- **Ground Water Screening Level**

  The Ground Water Screening Level is used to modify the value. The Ground Water Screening Level is the ground water concentration at which point a vapor impact may occur (NJDEP, 2012). The Ground Water Screening Level is not derived as a human health based value, but is back calculated from the Indoor Air Screening Level, which is health based, using the Johnson & Ettinger model (Johnson & Ettinger, 1991). Adjusting the concentration by dividing the value by the Ground Water Screening Level will allow the RPS model to compare analytes with different chemical parameters.

- The modified value is divided by the Ground Water Screening Level that is established in the SRP's "Vapor Intrusion Technical Guidance" document as of April 2012.

- **Mobility / Retardation**

Mobility is represented in the RPS Model by the Retardation Factor (R). The Retardation Factor is equal to 1+ (K_{oc}*f_{oc}* ρ /n_e) for organics and 1+ (K_{oc}* ρ /n_e) for inorganics (Freeze and Cherry, 1979). Default variables based on a typical site are used to calculate a Retardation Factor for all analytes (see table 3-6 for the default values). Mobility is considered because it controls contaminant migration. An analyte with a Retardation Factor greater than or equal to 2 are thought to be less mobile and the concentration is decreased accordingly.

Table 3-6. Default values used in Exceedance Quotient calculation

f_{oc}	Fraction of Organic Carbon	0.0002
ρ	Bulk Density	1.5
n_e	Porosity	0.3
K_{oc}	organic carbon/water partition coefficient	*

* = The value is determined by the contaminant or concentration

- If R is greater than or equal to 2, the value is divided by 2, otherwise it does not change.

- **Degradation / Half-life**

Degradation is represented in the RPS Model by the analytes' half-life ($t_{½}$). This is considered because it is one factor that controls contaminant migration (Freeze and Cherry, 1979). An analyte with a half-life of less than or equal to 2 is thought to be less persistent and the concentration is decreased accordingly.

- If $t_{½}$ is less than or equal to 2, the value is divided by 2, otherwise it does not change.

- **First-order attenuation rate constant**

Natural Attenuation processes reduce the contaminant concentration both spatially away from the source and temporally. The processes include a wide variety of physical, chemical and biological processes with the main process being dispersion and biodegradation. The concentration variations have been shown to follow a first order rate constant (USEPA, 2002). In evaluating the distribution of the HazSite data, the concentrations for each site implied a log normal distribution. To normalize the data based on natural attenuation, the natural log is taken.

- The natural log is taken of the modified value

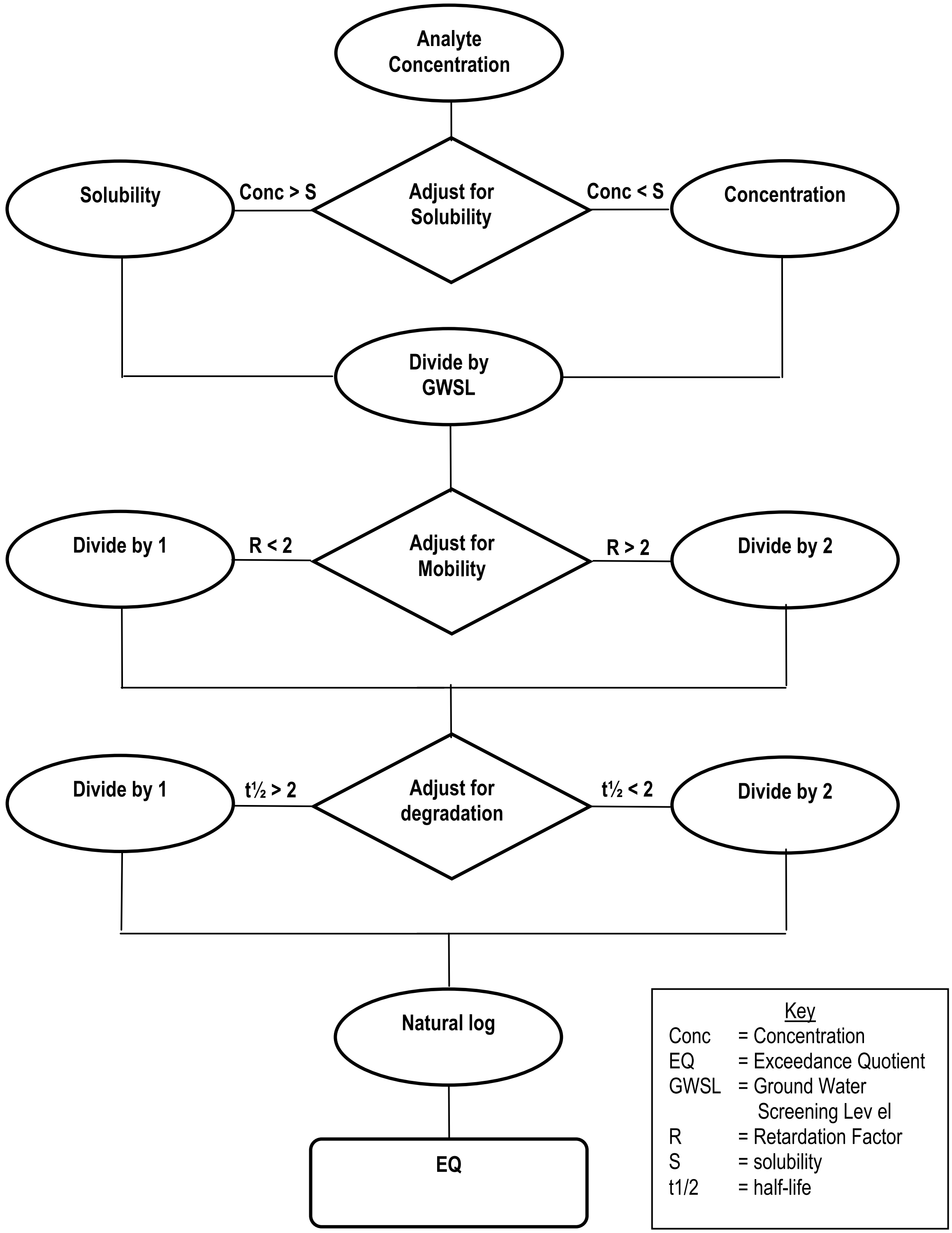
3.2.3.3. Vapor Exceedance Quotient

The Exceedance Quotient is the value that is calculated during the normalization process. Only one value is calculated for each analyte. Figure 3-4 represents the vapor normalization process. The Exceedance Quotients are used to generate the vapor Site Condition Score.

3.2.3.4. Final calculation for the Vapor Site Condition Score

The RPS Model employs a two-tailed Student's t-test to compute the 95% UCL for all Vapor Exceedance Quotient values (Appendix B). This final value is the Vapor Site Condition Score. The Vapor Site Condition Score is used to generate the Vapor Medium Score. If the sample population is less than 4, then the Vapor Site Condition Score is the average of the Exceedance Quotients and not the 95% UCL.

Figure 3-4. Steps used in the Exceedance Quotient normalization process for vapor Media.



3.2.3.5. Cases Missing HazSite Data

If HazSite ground water data are not available, then a surrogate value is assigned to the Vapor Site Condition Score. The value is based on the Bureau the case was assigned to prior to the LSRP program and is equal to the 75th percentile of the range of scores in that Bureau. Table 3-7 indicates the default value for the surrogate Soil Site Condition Score.

Table 3-7. Surrogate Vapor Site Condition Score by Bureau

Bureau	Vapor SCS Default
BCM	0.275
BER	2.190
BFO-N	2.581
BFO-S	2.644
BIDC	1.442
BISR	2.982
BOMM	1.963
BUST	1.932
CAS	2.671
EPA	2.190
OBR	2.867
OWR	0.839
RPIU	0.275
Site Assessment	0.275
Unknown Source	2.190
All other Bureaus	0.275

3.3. Pathway Score (NJEMS)

The Pathway Score for the specific medium is assigned based on the data in NJEMS. NJEMS stores information regarding the receptor evaluation for the case, specifically the information from the Receptor Evaluation Form.

A pathway is the route taken by the contaminant from the source to the receptor. A pathway is open when a contaminant can move freely from the source to a receptor. A pathway is closed when all potential risks have been evaluated and no chance of transport exists from the source to the receptor. For example, a site with delineation of ground water to the ground water screening levels, identification of all structures within the potentially affected area, and confirmation that all structures have not been affected according to SRP's "Vapor Intrusion Technical Guidance" Document would be considered a site with a closed pathway because the route taken by the contaminant is incomplete. The RPS Model refers to this as a Closed Pathway. An open pathway is given a value of one; while a closed pathway is given a value of zero. The RPS model assumes an open pathway until the pathway is confirmed to be closed. Some cases have more than one potential pathway for a single medium at a site. If a pathway is open at a site, the site will receive a value of one regardless of how many other pathways may be closed for that medium. SRP will use the requirements outlined in Table 3-8 to assign a closed pathway to a case.

Table 3-8. Criteria to turn off all of the Pathways that are evaluated by the RPS Model

Water Medium

Table 3-8a. Criteria to turn off the Ground Water Pathway Score

(Ground Water)	**Conditions necessary to turn off ground water pathway**
1.	Ground Water delineated to the GWQS
2.	Receptor Evaluation completed to the full extent of contamination
3.	No receptors (potable wells) are impacted
Applies to:	Domestic Wells layer, Public Community Wells layer, Public Non-Community Wells layer & Agricultural layer

Table 3-8b. Criteria to turn off the Surface Water Pathway Score

(Surface Water)	Conditions necessary to turn off surface water pathway
1.	Ground water delineated to the GWQS
2.	Receptor evaluation completed to the full extent of contamination
3.	No receptors (surface water) are impacted
Applies to:	Surface Water Intake layer and Water Body (Human Health) layer

Soil Medium

Table 3-8c. Criteria to turn off the Soil Pathway Score

	Conditions necessary to turn off soil pathway
1.	Soil contamination delineated to the Direct Contact Soil Remediation Standards
2.	Deed Notice, NFA or RAO for all contaminated AOCs
3.	No receptors are impacted
Applies to:	Soil Exposure: Residential layer, Soil Exposure: School layer and Soil Exposure: Day Care layer

Vapor Medium

Table 3-8d. Criteria to turn off the Vapor Pathway Score

	Conditions necessary to turn off vapor pathway
1.	Ground water delineated to the Ground Water Screening Level as outlined in the Vapor Intrusion Technical Guidance document
2.	Receptor evaluation completed to the full extent of contamination
3.	No Receptors (structures) are impacted
Applies to:	Vapor Exposure: Residential layer Vapor Exposure: School layer and Vapor Exposure: Day Care layer

Note: *If ground water was sampled and there is no vapor trigger for the site, then than the site will not have a vapor pathway evaluation.*

Ecological

Table 3-8e. Criteria to turn off the Ecological Pathway Score

	Conditions necessary to turn off ecological pathway
1.	Ground water delineated to the GWQS
2.	Ecological Evaluation completed
3.	No Ecological Receptors are impacted
Applies to	All Ecological layers

3.4. GIS Receptor (Receptor Layers, Receptor Class and Extent Areas)

There are several geoprocessing operations that are performed to generate a Receptor Score for each Receptor layer. The GIS Receptor layers are derived from the existing GIS layers available to SRP; the Extent Areas are created for each site and then overlain on the Receptor to generate the Receptor Score for each GIS Receptor layer.

3.4.1. GIS Receptor Layers

GIS Receptor layers are generated from existing geo-referenced databases and layers available to SRP, such as census data, municipal wells, lakes, streams, wetlands, schools and other significant receptors. The two classes of receptors (Human Health and Ecological Health) are evaluated and scored separately. The system is flexible and has been designed to allow for new Receptor Classes and/or Receptor layers to be added as needed. Appendix A outlines the details for each Receptor layer.

3.4.1.1 Human Health Receptor Class - The Human Health layers are grouped by the medium that they were developed to evaluate. The medium groups are water (ground water and surface water), soil and vapor. The specific layers included in the RPS Model are as follows:

- Water Medium
  - Private Wells
  - Community Supply Wells
  - Non-Community Supply Wells
  - Surface Water Intake
  - Water Body (Surface Water Quality Standards)
  - Agricultural
- Soil Medium
  - Soil Exposure: Residential,
  - Soil Exposure: School / Day Care
- Vapor Medium
  - Vapor Exposure: Residential
  - Vapor Exposure: School / Day Care

Note: The School / Day Care layers were created as one layer, but are scored separately in the RPS Model.

3.4.1.2. Ecological Health Receptor Layers - The Ecological Health layers are not grouped by medium. The specific layers included in the RPS Model are:

- Pinelands
- Highlands
- Water Body (Surface Water Quality Standards)
- Natural Heritage
- Landscape - Habitats and Animals
- Other Freshwater Wetlands
- Salt Water Marsh

A majority of the GIS Receptor layers were derived from existing GIS layers[2], but several are based on data maintained by the Division of Water Supply and Geoscience (DWSG). Table 3-9 includes the NJEMS fields that are used by the RPS Model to create the Supply Well GIS Receptor layers.

Table 3-9. NJEMS Division of Water Supply Information, which are used in the population served calculation

Field Name	Field Use
Ground Water Ratio	Percentage of Public Water System usage attributable to a ground water source
Maximum Population Served	Maximum Population Served by the Public Water System
Preferred ID	Unique identifier used to identify a program interest and link the NJEMS data to a well head protection area
Start Month / End Month	Date the water system withdrawal starts and ends for the season, which is used to determine percentage of year that the well is in service
Status (well)	Identifies the status of individual wells, particularly whether the well is active, not in use, or closed
Surface water ratio	Percentage of water supplied by surface water to a Public Water System
Total Population served	Total population served by a Public Water System, regardless of source
Water System Type	Classifies the Water System into Community or Non-Community and identifies the Non-Community Well as either transient or non-transient
Water Type	Ground water, ground water purchased, surface water, surface water

[2] The DEP GIS Layers available to the public are location at http://www.nj.gov/dep/gis/listall.html

Table 3-9. NJEMS Division of Water Supply Information, which are used in the population served calculation

Field Name	Field Use
	purchased

3.4.2. Assigning Cell Values to Receptor Layers

To enhance the performance of the RPS Model, Receptor vector data (points, lines and irregularly shaped polygons) are transformed into a raster format or grid format (for more information, see Appendix C). Each raster layer consists of a uniform grid of 100- by 100-foot **cells** extending across the state. A cell value is based on the risk associated with the receptors present within that cell for the layer being evaluated. Layers that are more sensitive to site contamination will have higher cell values. For example, higher cell values will be assigned to areas that have more private domestic wells because of the greater human health risk to a larger population (Figure 3-5). The cell values for each RPS layer are assigned based on population size and exposure duration or an evaluation of the relative risk of each layer to each other. Appendix A provides more information about the assignment of cell values for each GIS Receptor layer.

Figure 3-5. For the Private Wells GIS Layer, cell values are assigned based on the population density that is using private wells.

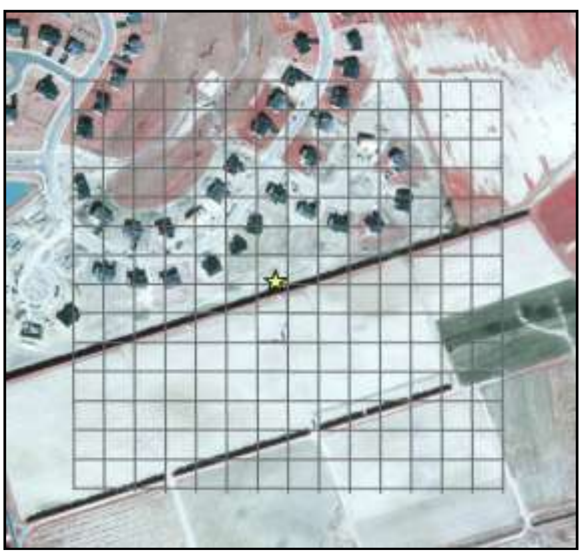


Figure 3-5a. The 100- by 100-foot grid that is overlain on the GIS layer used to evaluate potential receptors.

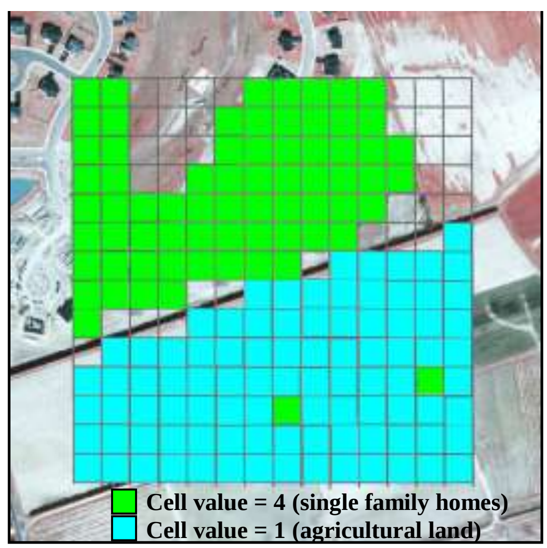


Figure 3-5b. Cell values are assigned based on population density. Cells with single family homes are assigned a value of 4 and agriculture land a value of 1.

3.4.3. Extent Area

The Extent Area is an approximation of the potential contamination at the site. It is critical to the RPS model because it determines the spatial relationship between the contaminants and the surrounding features and thus determines potential receptor impact. Whether the Extent Area is a ground water plume or an area of soil contamination, receptor risk cannot be identified accurately without accurate Extent Area information. The Regulations require the Extent Areas are now required to be submitted electronic. These GIS compatible polygons will be received by NJDEP upon full implementation of SRRA. When an Extent Area is not available electronically, SRP creates a surrogate Extent Area by buffering (Appendix C) the site coordinates with the size of the buffer based on the type of case. The area of this generalized buffer is known as the surrogate Extent Area, discussed in detail below.

3.4.3.1. Ground Water Extent Area

The RPS Model uses an electronic ground water plume to identify potential receptors in the vicinity of a site that might be at risk. Ground water plumes for a site are fully delineated during the Remedial Investigation phase. If the shape of the plume is not available electronically, SRP creates a surrogate Ground Water Extent Area as an input to the RPS model. As shown in Figure 3-6, the surrogate Extent Area can be circular or elliptical, depending on the data available. If the direction of ground water flow **is not** known, then a circular surrogate Extent Area is drawn around the site coordinates. If the direction of ground water flow **is** known, then an elliptical surrogate Ground Water Extent Area is drawn around the site coordinate in the direction of the ground water flow. The site is located along the major axis with the length of the down gradient axis being two times the length of the up gradient axis as shown on Figure 3-7. The shape of the ellipse is constant with the ratio of the major to minor axis for each ellipse being 3 to 1.

Figure 3-6. Two surrogate Ground Water Extent Areas are circular and elliptical.

The area of the surrogate Ground Water Extent Area is based on an analysis of previously established classification exception areas (CEAs)[3]. CEAs from each Bureau were reviewed and a median area was calculated based on that information. The areas for some Bureaus were adjusted based on case manager review. The area for both the circular and the elliptical buffers are equal. Table 3-10 shows the geometry of the surrogate Ground Water Extent Areas used in the RPS Model.

Figure 3-7. Geometry of the elliptical surrogate Ground Water Extent Area: The Ellipse is drawn with the site located along the major axis, which is oriented in the direction of flow.

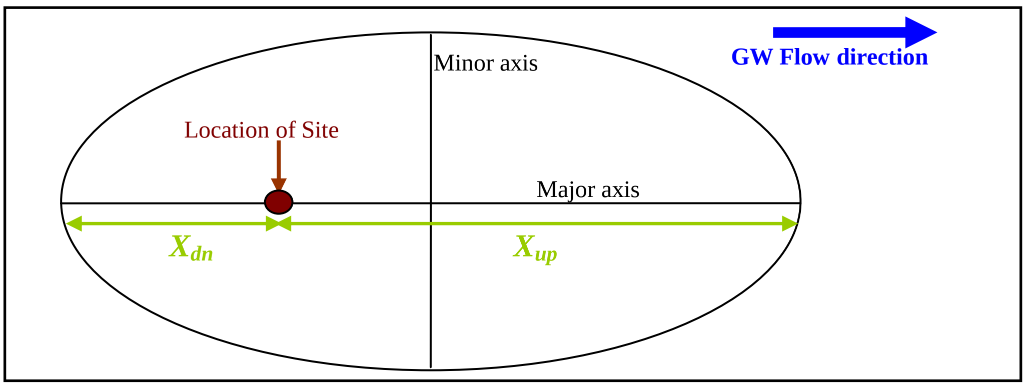


Table 3-10. The default surrogate Ground Water Extent Area by Bureau

Bureau	Area (acres)	Circle Radius (ft.)	Minor Axis (ft.)	Major Axis (ft.)	Location of Site on Major axis (ft.)	
					down gradient (X_{dn})	up gradient (X_{up})
BCM	30.5	650	2252	751	751	1501
BFO-N	6.5	300	1039	346	346	693
BFO-S	6.5	300	1039	346	346	693
BIDC	30.5	650	2252	751	751	1501
BISR	18.0	500	1732	577	577	1155
BOMM	4.2	240	831	277	277	554
BUST	4.2	240	831	277	277	554

[3] To learn more about Classification Exception Areas visit 7:9C-1.6 of the Ground Water Quality Standards web site at http://www.state.nj.us/dep/wms/bwqsa/docs/njac79C.pdf.

Table 3-10. The default surrogate Ground Water Extent Area by Bureau						
					Location of Site on Major axis (ft.)	
Bureau	Area (acres)	Circle Radius (ft.)	Minor Axis (ft.)	Major Axis (ft.)	down gradient (X_{dn})	up gradient (X_{up})
OBR	72.0	1000	3464	1155	1155	2309
OWR	72.0	1000	3464	1155	1155	2309
SA	72.0	1000	3464	1155	1155	2309
All other Bureaus	30.5	650	2252	751	751	1501

3.4.3.2. Soil Extent Area

The extent of soil contamination at a site is delineated during the Remedial Investigation phase. When these data are not available electronically, the RPS model uses one of two separate methods to create a surrogate. If Masterfile contains parcel(s) associated with the site, then the parcel area is used to identify the surrogate Soil Extent Area. The RPS model requires that the Extent Area be a single polygon. Sites with multiple parcels that are not contiguous are buffered by 100 feet and then dissolved into one polygon. Once the polygons are merged into one, the 100-foot buffer is then removed to return to the original size (Appendix C).

The entire area of all the parcels associated with the site is assumed to be the site boundary and is used to represent the estimated extent of soil contamination. If parcel(s) data **are not** available in Masterfile, then the RPS model creates a circular surrogate Soil Extent Area around the site's coordinates. The surrogate area is based on the 75th percentile of the parcel(s) in Masterfile grouped by Bureau. Table 3-11 identifies size of the surrogate Soil Extent Area used in the RPS Model when parcel data are not available.

Table 3-11. The surrogate Soil Extent Area by Bureau		
Bureau	Area (acres)	Circle Radius (ft.)
BCM	19.7	522
BER / BER-2	2.6	189
BER-1	1.2	128
BFO-N	1.8	157
BFO-S	2.7	195
BIDC	5.5	277
BISR	9.7	367

Table 3-11. The surrogate Soil Extent Area by Bureau		
Bureau	**Area (acres)**	**Circle Radius (ft.)**
BOMM	4.1	239
BUST	2.0	165
CAS	1.0	120
OBR	18.2	503
OWR	3.7	228
RPIU	2.7	194
SA	6.5	300
All other Bureaus	3.3	213

3.4.3.3. Vapor Extent Area

The RPS model uses the Ground Water Extent Area to create the Vapor Extent Area. The Ground Water Extent Area for a site is buffered by a set distance, which is based on the SRP "Vapor Intrusion Technical Guidance" document.[4] The sampling results from the HazSite data are used to determine if a vapor trigger exists and what size buffer to draw for a site. If a ground water result exceeds the Vapor Intrusion Ground Water Screening Level (GWSL), then a Vapor Extent Area is created. If all of the ground water results are below the GWSL or the case is soil contamination only, then an Extent Area is not created. The buffer is set at 100 feet unless only petroleum hydrocarbon contamination exceeds the Ground Water Screening Levels, in which case the buffer is 30 feet (Figure 3-8). Also, a 100-foot buffer is assumed if there is no HazSite ground water data. The Vapor Extent Area may be overestimated when it is based on a surrogate Ground Water Extent Area; however, adjusting the Extent Area based on the different contaminant and their standards cannot be done with the data available to the RPS Model.

[4] To learn more about Vapor Intrusion, visit http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm
The SRP Guidance document is located at (http://www.nj.gov/dep/srp/guidance/vaporintrusion/vig_main.pdf.)

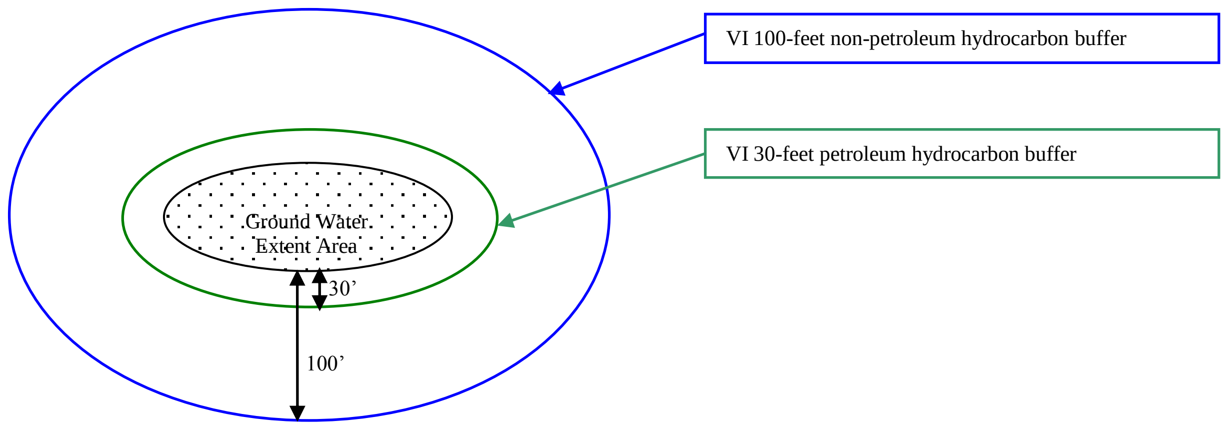


Figure 3-8. Creating a Vapor Extent Area: 30-foot and 100-foot Vapor buffer of a Ground Water Extent Area (not to scale).

3.4.4. Interaction between GIS Receptors Layers and Extent Areas

In order to calculate the number of potential receptors that may be affected by contamination at a site, the GIS Receptor layers are overlain by the Extent Areas for each site. More specifically, the Water Human Health Receptor layers are overlain by the Ground Water Extent Area, the Soil Human Health Receptor layers by the Soil Extent Area and the Vapor Human Health Receptor layers by the Vapor Extent Area. The cell values for each receptor layer that are within the associated Extent Area are used to generate a score for the Receptor layer. Appendix A describes, in detail, the process to calculate a Receptor Score for each Receptor layer.

Figure 3-9 depicts the process including rasterizing the layer (for more information, see Appendix C) that is used to create the Potable Well layer (figure 3-9a, 3-9b and 3-9c) and then calculate a Private Potable Receptor Score by overlaying the Ground Water Extent Area is overlain the rasterized Potable Well layer (figure 3-9d). A Receptor layer Score is calculated from the identified cell values from within the Extent Area.

3.5. RPS Model Inputs

Section 3 outlines how the RPS model uses the information available to SRP to establish the Model Input values. The RPS Model Input values are:

- Contamination Score:
  - Ground Water SCS
  - Soil SCS
  - Vapor SCS
- Pathway Scores

- Ground Water Pathway Score
- Surface Water Pathway Score
- Soil Pathway Score
- Vapor Pathway Score
- Ecological Pathway Score

- Receptor Scores

  - Human Health Class

    - Water Medium (*6 layers*)
      - Private Wells
      - Community Wells
      - Non-Community Wells
      - Surface Water Intake
      - Water Body (Surface Water Quality Standards)
      - Agricultural
    - Soil Medium (*3 layers*)
      - Soil Receptors: Residential
      - Soil Receptors: School
      - Soil Receptors: Day Care
    - Vapor Medium (*3 layers*)
      - Soil Receptors: Residential
      - Soil Receptors: School
      - Soil Receptors: Day Care

Figure 3-9. Process to calculate a Receptor Score for Private Potable Wells. A 100-foot grid is used to rasterize the Vector data to generate the Receptor Layer and Ground Water Extent Area, and then calculate the Private Potable Receptor Score for the site. The final Potable Well Receptor Score for this example is 64.

Figure 3-9a. The General site location.

Figure 3-9b. A 100- by 100-foot grid used to Rasterize the Vector data *(cells not to scale).*

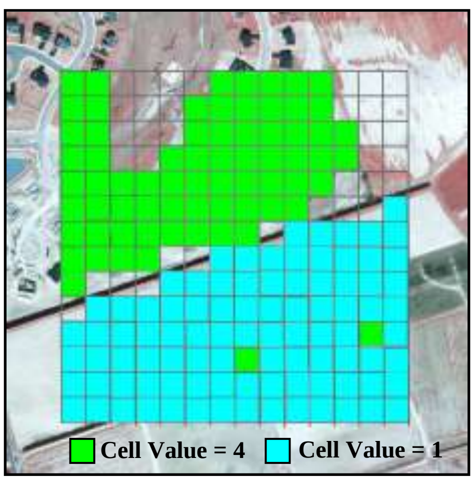


Figure 3-9c. Potable Well Layer: Cell Values in the Receptor Layer are assigned based on criteria identified in Appendix A.

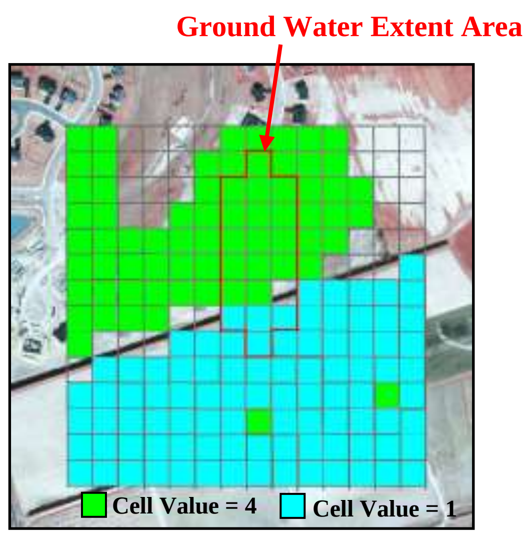


Figure 3-9d. The Ground Water Extent Area is overlain over the Receptor Layers. Count cell values within the Extent Area.

15 cells with a Cell Value of 4 **Sub total = 60**

4 cells with a Cell Value of 1 **Sub total = 4**

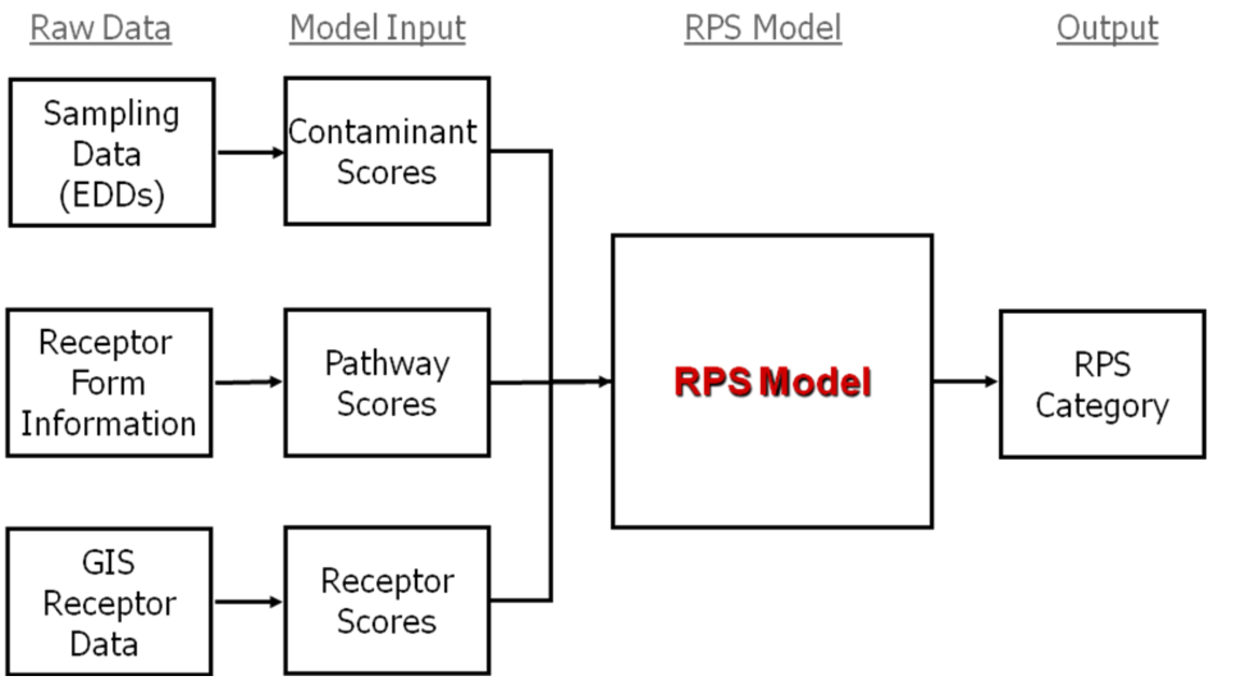
Private Potable Receptor Score = 64

- Ecological Health Class
  - Pinelands.
  - Highlands
  - Water Body (Surface Water Quality Standards)
  - Natural Heritage
  - Landscape
  - Wetlands
  - Coastal Wetlands

4. RPS Model

The "CPR" methodology is employed for each medium to calculate a final receptor score. The input values to the RPS model are Contaminant Score, Pathway Score, and the Receptor Score. Section 3 outlines how the RPS model uses the information available to SRP to calculate the Model Input values. Figure 4.1 outlines the relationship between the raw data, the Model Input and the RPS model.

Figure 4-1. Diagram outlining the overall relationship between the raw data and the RPS model.



4.1 RPS Model Calculations

The basic formula used in the RPS Model is:

Contaminant Score *multiplied by* Pathway Score *multiplied by* Receptor Score

Attachment D shows the output to the RPS model. The RPS scores the Human Health Receptor Class and the Ecological Receptor Class separately.

4.1.1. Human Health Score

As previously stated, the Human Health Class is subdivided into three media (water, soil and vapor). The RPS scores each medium and then sums the results of the individual medium.

4.1.1.1. Water Medium Score

The Water Medium consists of ground water and surface water. The process to calculate the Water Medium Score is as follows:

1. The Score for each Receptor layer is multiplied by the Pathway Score applicable to that layer. The product is the Water Receptor Score.
2. The Receptor Scores are summed; this is the Water Receptor Medium Score.
3. The Water Receptor Medium Score is then multiplied by the Ground Water Site Condition Score to calculate the Water Medium Score.

Figure 4-2 is the formula used to calculate the Water Medium Score. The scoring process for the Water medium is displayed in Appendix D, Section II.A.

Figure 4-2. Equation to calculate the Water Media Score.

$$\text{Water Media Score} = \left(\sum (\text{Receptor Layer Score} \times \text{Pathway Score})\right) \times \text{GW SCS}$$

Where the Receptor Layers are:

Receptor Layer Score	*Pathway Score*
○ *Private Wells*	*Ground Water Pathway*
○ *Community Wells*	*Ground Water Pathway*
○ *Non-Community Wells*	*Ground Water Pathway*
○ *Surface Water Intake*	*Surface Water Pathway*
○ *Water Body*	*Surface Water Pathway*
○ *Agricultural*	*Ground Water Pathway*

4.1.1.2. Soil Medium Score

The process to calculate the Soil Medium Score is as follows:

1. The Score for each Receptor layer (Receptor Layer Score) is summed. The result is the Soil Receptor Score.
2. The Soil Receptor Score is multiplied by the Soil Pathway Score and the Soil Site Condition Score.

Figure 4-3 is the formula used to calculate the Soil Medium Score. The scoring process for the Soil medium is displayed in Appendix D, Section II.B.

Figure 4-3. Equation to calculate the Soil Media Score.

$$\text{Soil Media Score} = (\sum \text{Receptor Layer Score}) \times \text{Soil Pathway Score} \times \text{Soil SCS}$$

Where the Receptor Layers are:

- *Soil Receptors: Residential*
- *Soil Receptors: School*
- *Soil Receptors: Day Care*

4.1.1.3. Vapor Medium Score

The process to calculate the Vapor Medium Score is as follows:

1. The Score for each Receptor layer (Receptor Layer Score) is summed. The result is the Vapor Receptor Score.
2. The Vapor Receptor Score is multiplied by the Vapor Pathway Score and the Vapor Site Condition Score.

Figure 4-4 is the formula used to calculate the Vapor Medium Score. The scoring process for the Vapor medium is displayed in Appendix D, Section II.C.

Figure 4-4. Equation to calculate the Vapor Media Score.

$$\text{Vapor Media Score} = (\sum \text{Receptor Layer Score}) \times \text{Vapor Pathway Score} \times \text{Vapor SCS}$$

Where the Receptor Layers are:
- *Vapor Receptors: Residential*
- *Vapor Receptors: School*
- *Vapor Receptors: Day Care*

4.1.1.4. Human Health Score

The process to calculate the final Human Health Score is as follows:

1. The Final Water, Soil and Vapor Medium Scores are summed to produce the final Human Health Score.

Figure 4-5 is the formula used to calculate the Human Health Score. The scoring process for the Human Health Score is displayed in Appendix D, Section II.D.

Figure 4-5. Equation to calculate the Human Health Score.

$$\text{Human Health Score} = (\text{Water Media Score} + \text{Soil Media Score} + \text{Vapor Media Score})$$

4.1.2. Ecological Health Score

The process to calculate the Ecological Health Score is as follows:

1. The score for each Receptor layer (Receptor Layer Score) is summed. The result is the Ecological Receptor Score.
2. The Ecological Receptor Score is multiplied by the Ecological Pathway Score.

Figure 4-6 is the formula used to calculate the Ecological Medium Score. The scoring process for the Ecological medium is displayed in Appendix D, Section III.

Figure 4-6. Equation to calculate the Ecological Health Score.

$$(\sum \text{Receptor Layer Score}) \times \text{Ecological Pathway Score}$$

Where the Receptor Layers are:

- Pinelands.
- Highlands
- Water Body
- Natural Heritage
- Landscape
- Wetlands
- Coastal Wetlands

4.2. RPS Final Score

An individual score is calculated for each Receptor Class. The Class results are not combined. At this time, the RPS has two separate RPS Scores. The RPS Model uses these scores to rank the sites into the different categories.

5. Final RPS Categories (Jenks' Breaks)

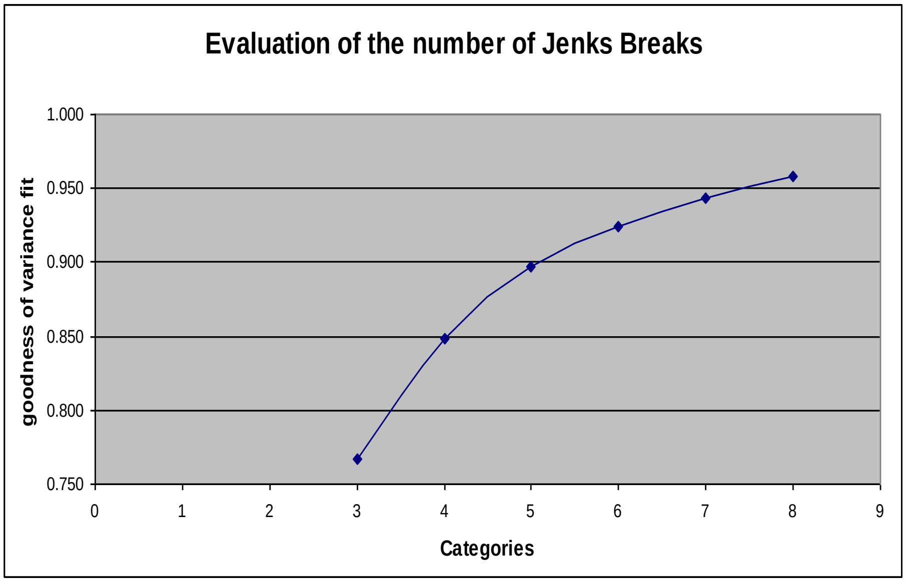
Once a final RPS score has been calculated, the resulting value is categorized using "Jenks' natural breaks" to describe the cumulative risk posed by each site (Jenks, 1967) (McMaster, 1997). A natural break is a data classification method designed to place the best arrangement of values into different classes. This is done by seeking to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means of the other groups. In other words, the method seeks to reduce the variance within classes and maximize the variance between classes. SRP refers to these classes as categories. The Goodness of Variance Fit was evaluated to determine the correct number of breaks to establish (North, 2009). Based on the evaluation performed (Table 5-1), NJDEP decided on using 4 breaks (5 Categories) for the RPS scores. The categories range from 1 to 5. Category 1 includes sites with the lowest RPS scores and Category 5 includes sites with the highest RPS scores. These categories were established to comply with N.J.S.A. 58:10-23.16 as amended in section 39 of P.L. 2009, c.60.

Periodically, SRP will need to re-run the RPS Model for new sites and those sites with updated information. This will change the population distribution and the Jenks Natural Breaks. To prevent the breaks from constantly changing, SRP has decided to hold the category values for a period of at least one year. The breaks also will be updated when a major change to the model occurs. Interim runs of the RPS model will not affect category values.

Table 5-1. The Goodness of Variance Fit was evaluated to determine the correct number of breaks to establish.

Categories	GVF
3	0.767
4	0.848
5	**0.897**
6	0.924
7	0.944
8	0.958

GVF = Goodness of Variance Fit



The "natural break" ranges and corresponding categories are shown in Table 5-2. Both privately funded sites and public funded sites are included. If a site is in a category 5 and the site is being remediated on schedule without any compliance issues or flags, remediation can continue under the oversight of an LSRP. Sites in high categories **may** be considered for SRP review if there are compliance issues.

Table 5-2. RPS Breaks and Categories

Natural Break Ranges	Category
*	5
*	4
*	3
*	2
*	1

Note: * *Once the model is run, then the breaks will be established, posted and included in this document.*

6. Feedback Loop

During the summer of 2012, NJDEP is allowing Responsible Entities (RE) the opportunity to review the RPS Model input data for inaccuracies and update NJDEP's databases. This process or "Feedback Loop" will allow the RPS Model to better represent potential risks at a site by using the best input data possible. At this time, the model would have to use default values to categorize a large percentage of the sites because of data gaps in NJDEP databases. This feedback loop will allow REs the chance to correct the data and fill in the data gaps.

The Feedback Loop includes two steps that will require the Responsible Entity or Responsible Entity designee to register on-line to request limited additional information and then a second step to change the input data. A form has been created for each step of the process (Appendix E). The RPS Information Request Form will allow REs or their designee to request additional information. Once the form is received, NJDEP will provide information maps and electronic data that will be used to score the site. Requests to change the input data will be received via the RPS Feedback Form with the submission being submitted by an LSRP (unless the case is an EPA lead or a federal facility). If changes can be made without the additional information, the first step of the loop can be omitted. The RPS Feedback Form can be provided to the Department without having submitting the RPS Information Request Form.

The RPS will be calculated in the Fall of 2012 based on the information received during the Feedback Loop process. The RPS categories will be posted on the SRP web site. Submitters will be notified when a decision is made on their submission and score.

The RPS will be updated periodically when new data are received by NJDEP. All Updates will be posted via the next RPS posting. Currently, the goal is to post RPS scores biannually the first year and quarterly thereafter. The feedback received during this process will allow SRP to evaluate the model components for trends via data analysis, ad hoc queries and reports. The findings also will assist in the prioritization of revisions and upgrades to the RPS Model as resources allow.

7. Conclusion

RPS is a model. It is intended to represent the potential risk associated with potential receptors, site conditions and contaminant pathways for a site. The RPS score is calculated to determine a relative categorization of contaminated sites that pose the greatest potential risk to human health and the environment. There is no perfect model for determining risk; therefore, all models must be improved over time to achieve the greatest possible accuracy and reliability. Through investigation and data development SRP has improved the RPS model substantially since the last version. For example, the model now includes soil and vapor intrusion pathways in its calculations. In addition, the Exceedance Quotient calculations now include solubility, mobility, degradation, and other factors that improve the accuracy of the site condition score. Population and exposure data has also been added to improve most of the Human Health layers. The RPS model will continue to apply statistically supported surrogate values when necessary. As the process moves forward, the goal is to replace surrogate values with site-specific information and enhance the model to best characterize the risks at the site.

The RPS Model is not stagnant. It will continue to be upgraded and improved. New components will be added, as needed, to enhance the output. In addition, routine updates to the GIS layers will have to be performed as population data and land use change. All parties share an interest in representing site impacts as accurately as possible whether the goals involve identifying and addressing the most significant site concerns, limiting liability, reducing cleanup costs, or protecting human health and the environment.

Appendix A – GIS Receptor Layers

Human Health Layers

A1. Private Wells [5]

Receptor Class: Human Health **Medium Type:** Ground Water

Mode of Exposure –The exposure pathway evaluated by this layer is the potential for people with private potable wells to drink contaminated ground water emanating from a site. The GIS layer attempts to delineate the areas where ground water contamination could impact a private well.

Background – Private potable wells serve a dwelling unit and are located on the same real property as the dwelling unit. The Private Wells layer is a derived layer based on NJDEP Water Purveyor and Land Use layers. Geographic areas that are serviced by public water, as identified by the NJDEP Water Purveyor layer, are assumed to not have private wells. Areas that are not covered by the Water Purveyor layer are assumed to have private wells. Currently, the population of an area is assigned to the classes included in the 1995 Land Use GIS coverage. Each land use class was given a general population density based on the statewide 2000 census values.

Cell Value Origins – The value for each cell is based on the population density and exposure duration. The population density is calculated for land use types and the value for each type is derived from the 2000 census data. The exposure duration is assumed to be 20 years, which is a theoretical time between sampling of a private domestic well. The cell value equals the population density (people per cell) multiplied by an exposure period of twenty years. Cells serviced by public water are set to 0. Table A1-1 the shows the cell values for each land use type. Figure A1-1 is the Private Wells layer for the entire State used in the RPS model.

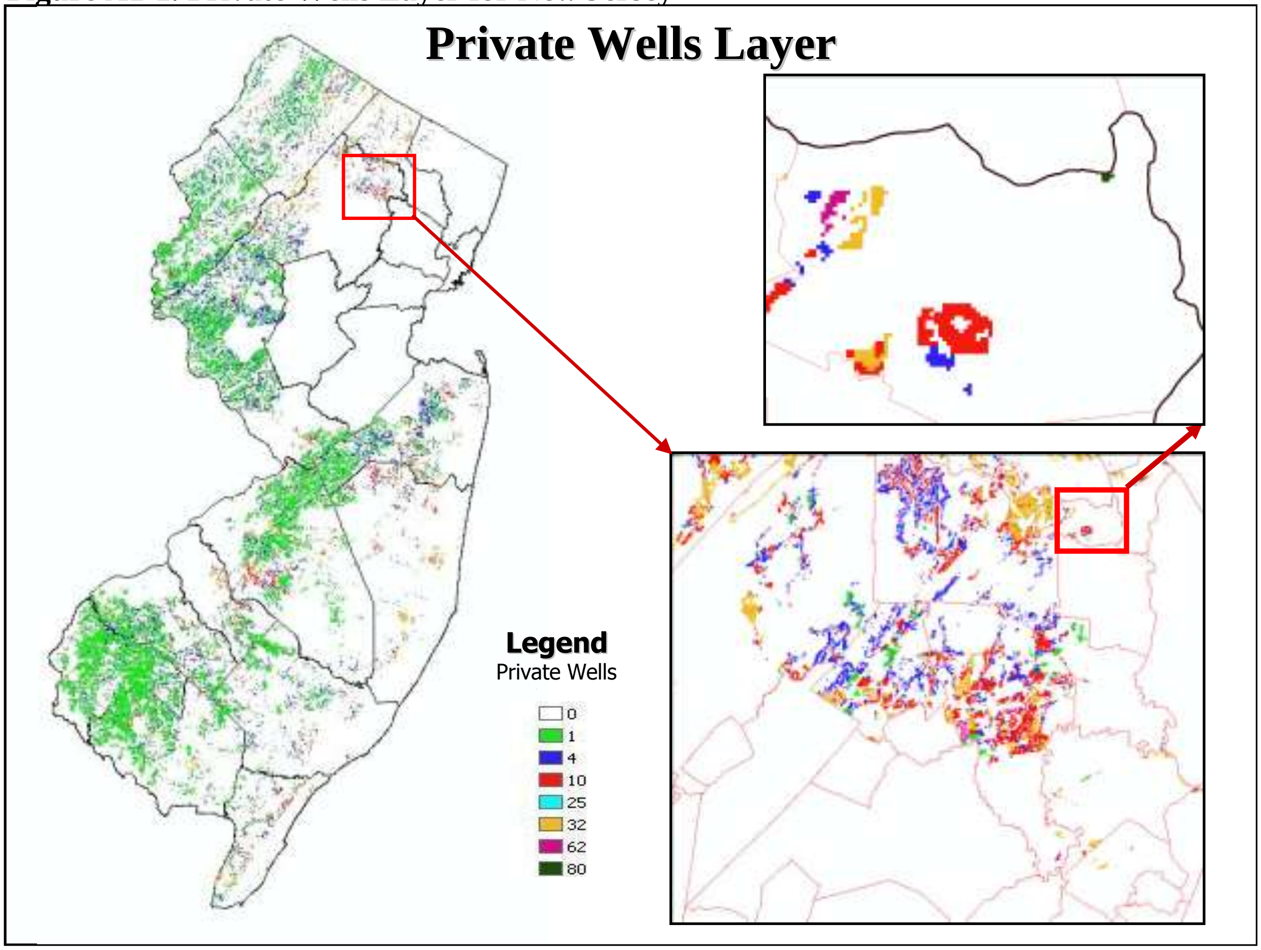
Table A1-1. Cell Values for the Private Wells Layer

Land Use Type	**Cell Value**
Agricultural wetland, croplands, pastures, orchards, vineyards, horticulture, plantations, general agriculture	1
Residential, rural, single units	4

[5] Learn more about the New Jersey Private Well Testing Act at http://www.nj.gov/dep/pwta/

Table A1-1. Cell Values for the Private Wells Layer	
Land Use Type	**Cell Value**
Residential, single units, low density	10
Mixed residential	25
Residential, single units, medium density	32
Residential, high density, multiple dwellings	62
Mixed urban or built up land	80

Figure A1-1. Private Wells Layer for New Jersey



Receptor Score Calculation Method - To calculate the Receptor Score, the Private Wells layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed because the cell value is based on population density.

Issues / Future Plans –

- The creation of the land use layer involved photo interpretation.
- Incorporation of newer data for both census and land use.
- There are some uncertainties regarding the well purveyor areas and the layer was last updated in 1998.
- Private Wells can be found within the purveyor areas.
- Future plans are to improve upon these scores by using dasymetric mapping[6] which will enable SRP to derive more accurate population densities via local census population values adjusted by underlying land use layers.
- Attempts will be made to base the Private Wells layer on known well locations rather than relying on implied locations.

[6] Dasymetric Mapping is discussed at http://geography.wr.usgs.gov/science/dasymetric/index.htm

A2. Public Community Water Supply Wells [7]

Receptor Class: Human Health **Medium Type:** Ground Water

Mode of Exposure –The exposure pathway is people drinking contaminated ground water from public community water supply wells. The GIS layer attempts to delineate areas where ground water contamination could impact public potable water sources.

Background – A public community water supply well supplies water to a public community water system. A public water system (PWS) provides public water for human consumption through pipes or other constructed conveyances. A public community water system serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents and the water sources can be both ground and/or surface water.

The 1986 Federal Safe Drinking Water Act Amendments (Section 1428, P.L. 93-523, 42 USC 300 et. seq.) required New Jersey to create a Well Head Protection Program. An integral part of the Program is the creation of Well Head Protection Areas (WHPA). The WHPA is the area from which a well draws its water within a specific time frame. Each WHPA is divided into three tiers based on the anticipated length of time for ground water to reach the well. The tiers are as follows:

- Tier 1: Contamination takes less than 2 years to travel from the source to the well head. This duration is based on the assumed time that pathogens can survive in ground water. The area on the map also corresponds with the cone of depression of the wells reviewed during the development of the RPS Model
- Tier 2 - Contamination takes 2-5 years to travel from the source to the well head.
- Tier 3: Contamination takes 5-12 years to travel from the source to the well head.

The methods to delineate a WHPA area in New Jersey are described in NJDEP's "Guidelines for Delineation of Well Head Protection Areas in New Jersey (NJDEP, 2003). WHPAs are created for both Public Community Water Supply Wells and Public Non-Community Water Supply Wells and the New Jersey Geological Survey maintains these GIS WHPA layers.

Cell Value Origins – Cell values are based on population served, exposure duration, and the WHPA tiers. The WHPA has already been delineated for each public community water supply well

[7] Learn more about Public Water Systems and Well Head Protection Program at http://www.nj.gov/dep/watersupply/

by NJDEP. NJEMS was used to provide an estimate of the population served by each PWS. Since population data are only available for water systems and not for individual wells, it was assumed that every well in a system served an equal population. In other words, the system population was divided by the number of wells in each system in order to calculate the population served by each well. Next, because public community water systems monitoring for contamination ranges between quarterly and every three years, an average exposure period of semi-annual was chosen and the population served was divided by 2 (exposure period of 0.5 years). Finally, to account for the distance the site is away from the wellhead, the cell value was adjusted by multiplying by a factor depending on the WHPA tier. The Tier Factors used were 1.0 for tier 1, 0.5 for tier 2 and 0.1 for tier 3. The factor for Tier 2 was based on the ratio of the area of tier 1 to the combined area of tier 1 and tier 2 for tier 2 and factor for Tier 3 was based on the ratio of the area of tier 1 to the combined area of tier 1, tier 2, and tier 3. For each well, a cell value was calculated by multiplying the population served by each well multiplied by the exposure duration and the Tier factor.

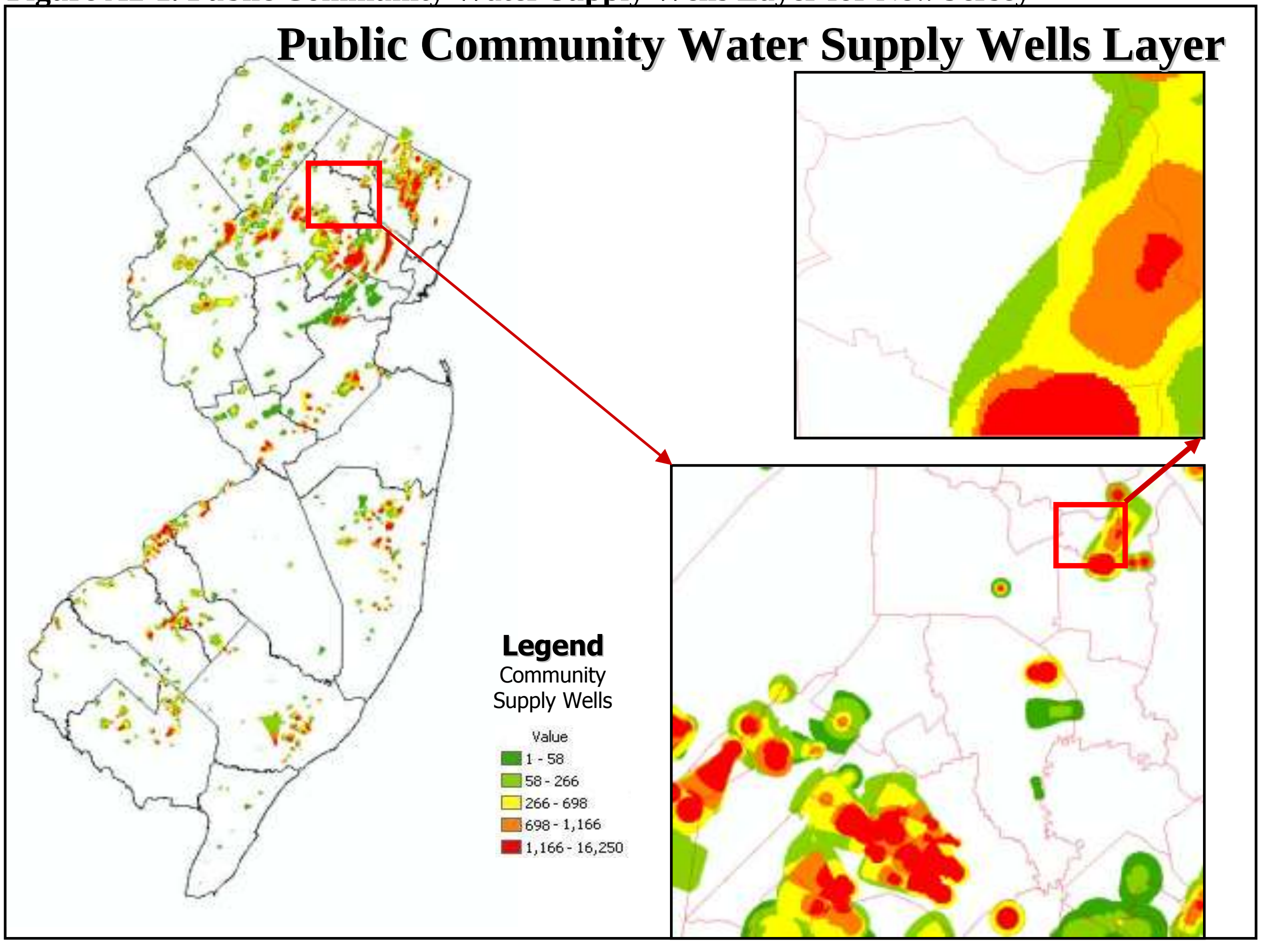
However, there are many situations where public community water supply wells are located in close proximity to one another and the WHPAs for these wells overlap. If there are multiple WHPA for the same cell, then the population served by each well needs to be taken into consideration. To do this, the cell values for each WHPA are summed to produce a final cell value for the Public Community Water Supply Well layer for the entire State (Figure A2-1).

Receptor Score Calculation Method - To calculate the Receptor Score, the Public Community Water Supply Wells layer is overlain by the Ground Water Extent Area for the site. The maximum cell value that is within the Ground Water Extent Area is the Receptor Score since the cell value is based on the total population served by the well and not the population density

Issues / Future Plans –

- Estimating the population serviced by each well is very difficult. SRP will try to improve this estimate in the future.
- The actual well pumpage is variable. Assumptions were made during the creation of this layer and the values are based on the population served statistics submitted to NJDEP.

Figure A2-1. Public Community Water Supply Wells Layer for New Jersey



- The sampling frequency for each well is variable. An estimate of semi-annual sampling was thought to represent the average duration between sampling events.
- The WHPA tiers are used to modify the Receptor Score based on specific distances from the wellhead. The WHPA tiers were created using site specific aquifer characteristics for the specific well; however, this may not be indicative of the actual contaminant transport within the supply well's capture zone. The WHPAs were used because they are mapped for every supply well and have been reviewed prior to issuance.
- The current "tier factors" (1.0, 0.5, and 0.1) are based strictly on geometry and they may need to be revised in the future.

A3. Public Non-Community Water Supply Wells [8]

Receptor Class: Human Health **Medium Type:** Ground Water

Mode of Exposure –The exposure pathway is people drinking contaminated ground water from Non-Community Water Supply Wells. The GIS layer attempts to delineate areas where ground water contamination could affect non-community Public water supply wells.

Background – A non-community public water supply well supplies water to a non-community PWS, which can serve both non-transient and transient populations. A non-transient non-community public water supply well serves at least 25 of the same persons over a period of six months in any given calendar year (i.e. schools, hospitals and office buildings). A transient non-community public water supply well serves at least 25 transient individuals present for at least 60 days in any given calendar year, but does not serve the same individuals during that time period (i.e. restaurants, gas stations).

The 1986 Federal Safe Drinking Water Act Amendments (Section 1428, P.L. 93-523, 42 USC 300 et. seq.) required New Jersey to create a Well Head Protection Program. An integral part of the Program is the creation of Well Head Protection Areas (WHPA). The WHPA is the area from which a well draws its water within a specific time frame. Each WHPA is divided into three tiers based on the anticipated length of time for ground water to reach the well. The tiers are as follows:

- Tier 1: Contamination takes less than 2 years to travel from the source to the well head. This duration is based on the assumed time that pathogens can survive in ground water. The area on the map also corresponds with the cone of depression of the wells reviewed during the development of the RPS Model
- Tier 2 - Contamination takes 2-5 years to travel from the source to the well head.
- Tier 3: Contamination takes 5-12 years to travel from the source to the well head.

The methods to delineate a WHPA area in New Jersey are described in NJDEP's "Guidelines for Delineation of Well Head Protection Areas in New Jersey" (NJDEP, 2003). WHPAs are created for both Public Community Water Supply Wells and Public Non-Community Water Supply Wells and the New Jersey Geological Survey maintains these GIS WHPA layers.

[8] Learn more about Public Water Systems and Well Head Protection Program at http://www.nj.gov/dep/watersupply/

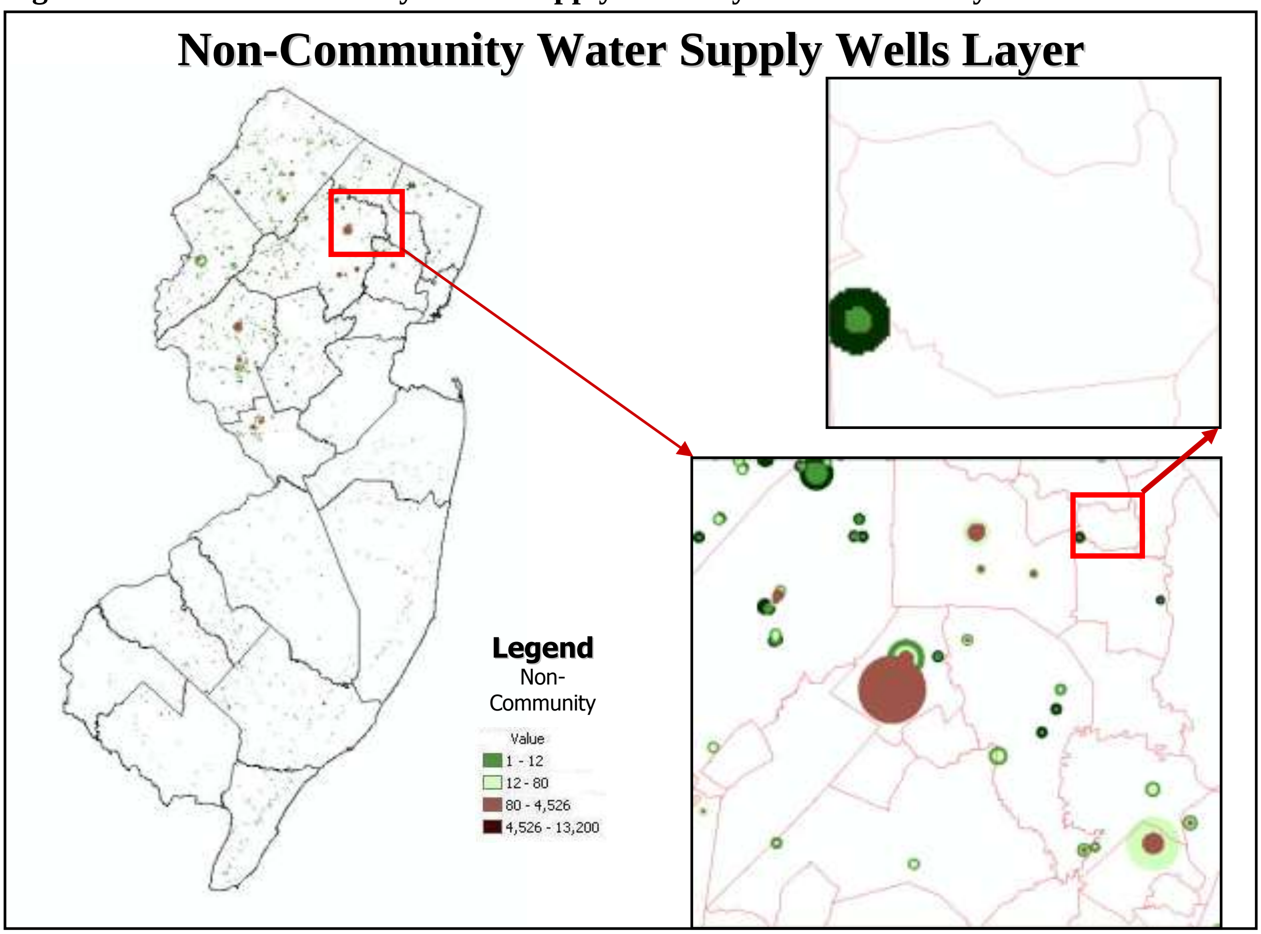
Cell Value Origins – Cell values are based on population served, exposure duration, and the WHPA tiers. The WHPA has already been delineated for each public non-community water supply well by NJDEP. NJEMS was used to provide an estimate of the population served for each PWS. The non-community public water supply wells can serve both transient and non-transient populations. Adjustments to the NJEMS population values had to be made to account for:

- Different exposure durations of the transient and non-transient populations. The non-transient population is not served full-time by the PWS so the non-transient population had to be normalized to the transient population. It was decided to assume that the transient population potential exposure was only 5% of the non-transient populations (the non-transient population was multiplied by 0.05). This assumes that non-transients are present approximately 2 hours during a 40-hour workweek.
- Months of operation of the PWS. Some Non-Community Supply Wells are not used year round (i.e. schools or summer use only). The population values were adjusted based on the yearly usage (population was multiplied by the ratio of months in operation to 12 months) that the population was served by the system.
- Unavailable NJEMS data. Population data was not available for numerous wells based on problems with the data sets. The following steps were used to assign estimated populations in this situation:
    1. All non-community systems were assigned a type (such as residential, business, hospital, or school).
    2. Then the median population was calculated for each type using only systems with NJEMS population data.
    3. Finally, the non-community WHPAs without NJEMS population data were assigned the median population of its corresponding type.

Once the adjustments were made, the non-transient and transient populations were added together for each PWS to get the total population served. Since population data are only available for water systems and not for individual wells, it was assumed that every well in a system served an equal population. In other words, the system population was divided by the number of wells in each system in order to calculate the population served by each well. Next, because non-community PWS are normally monitored for contamination approximately once every two to three years, an exposure period of two years was chosen (the population served was multiplied by 2). Finally, to account for the distance the site is away from the wellhead, the cell value was adjusted by multiplying by a factor depending on the WHPA tier. The factors used were 1.0 for tier 1, 0.5 for tier 2 and 0.1 for tier 3. These values were based on the ratio of the area of tier 1 to the combined area of tier 1 and tier 2 for tier 2 and the ratio of the area of tier 1 to the combined area of tier 1, tier 2, and tier 3 for tier 3. For each well, a cell value was calculated by multiplying the population served by each well by the exposure duration by the Tier factor.

However, there are situations where several public non-community water supply wells are located in close proximity to one another and the WHPAs for these wells overlap. If there are multiple WHPA for the same cell, then the population served by each well needs to be taken into consideration. To do this, the cell values for each WHPA are summed to produce a final cell value for the Public Non-Community Water Supply Wells layer for the entire State (Figure A3-1).

Figure A3-1. Non-Community Water Supply Well Layer for New Jersey



Receptor Score Calculation Method - To calculate the Receptor Score, the Non-Community Water Supply Wells layer is overlain by the Ground Water Extent Area for the site. The maximum cell is a value that is within the Ground Water Extent Area and is used since the cell value is based on total population served and not the population density.

Issues / Future Plans –

- Estimating the population serviced by each well is very difficult. SRP will try to improve this estimate in the future.
- The actual well pumpage is variable. Assumptions were made during the creation of this layer and the values are based on the population served statistics submitted to NJDEP.
- The sampling frequency for each well is variable. An estimate of bi-annual sampling was thought to represent an average duration between sampling events.
- The WHPA tiers are used to modify the Receptor Score based on specific distances from the wellhead. The WHPA tiers were created using site specific aquifer characteristics for the specific well; however, this may not be indicative of the actual contaminant transport within the supply well's capture zone. The WHPAs were used because they are mapped for every supply well and have been reviewed prior to issuance.
- The current "tier factors" (1.0, 0.5, and 0.1) are based strictly on geometry and they may need to be revised in the future.
- The GIS WHPA layer that was used to calculate the Non-Community Supply Wells layer was last updated in 2004.

A4. Surface Water Intake [9]

Receptor Class: Human Health **Medium Type:** Surface Water

Mode of Exposure –The exposure pathway is people drinking contaminated surface water migrating to the water body by overland flow or ground water baseflow. The GIS layer attempts to delineate areas where surface water contamination could affect potable water sources.

Background - The New Jersey Water Supply Master Plan identifies several major surface water systems throughout the State. The waters purveyors that operate these systems may have one or more of the following: a run-of-the-river reservoir system (a reservoir created by constructing a dam across a river), a surface water intake (which pumps water from a river to a reservoir for storage), or a surface water intake that directly diverts water from a river to the water treatment facility. Four scores were used to identify and delineate these areas: surface water intake points, stream layer, water supply management areas, and the 2002 land use layer. These layers were used to identify and buffer wetlands, lakes and streams by 300-foot and 500-foot buffers for 1 mile upstream of a Surface Water Intake. The 300-foot buffer was used to be consistent with the Stormwater Management and Flood Hazard Area Control Acts (N.J.A.C. 8:8, N.J.A.C. 7:13).

Cell Value Origins – Lakes and streams were scored higher than wetlands; the 300-foot buffer was scored higher than the 500-foot buffer. A comparison was made between the Surface Water Intake data and the well layers, which are based on population and exposure duration. Table A4-1 indicates the cell values assigned to the Surface Water Intake layer. These values were given an appropriate range based on relative risk of the Surface Water Intake in comparison to the Potable Well values. Figure A4-1 is the Surface Water Intake layer for the entire State used in the RPS model.

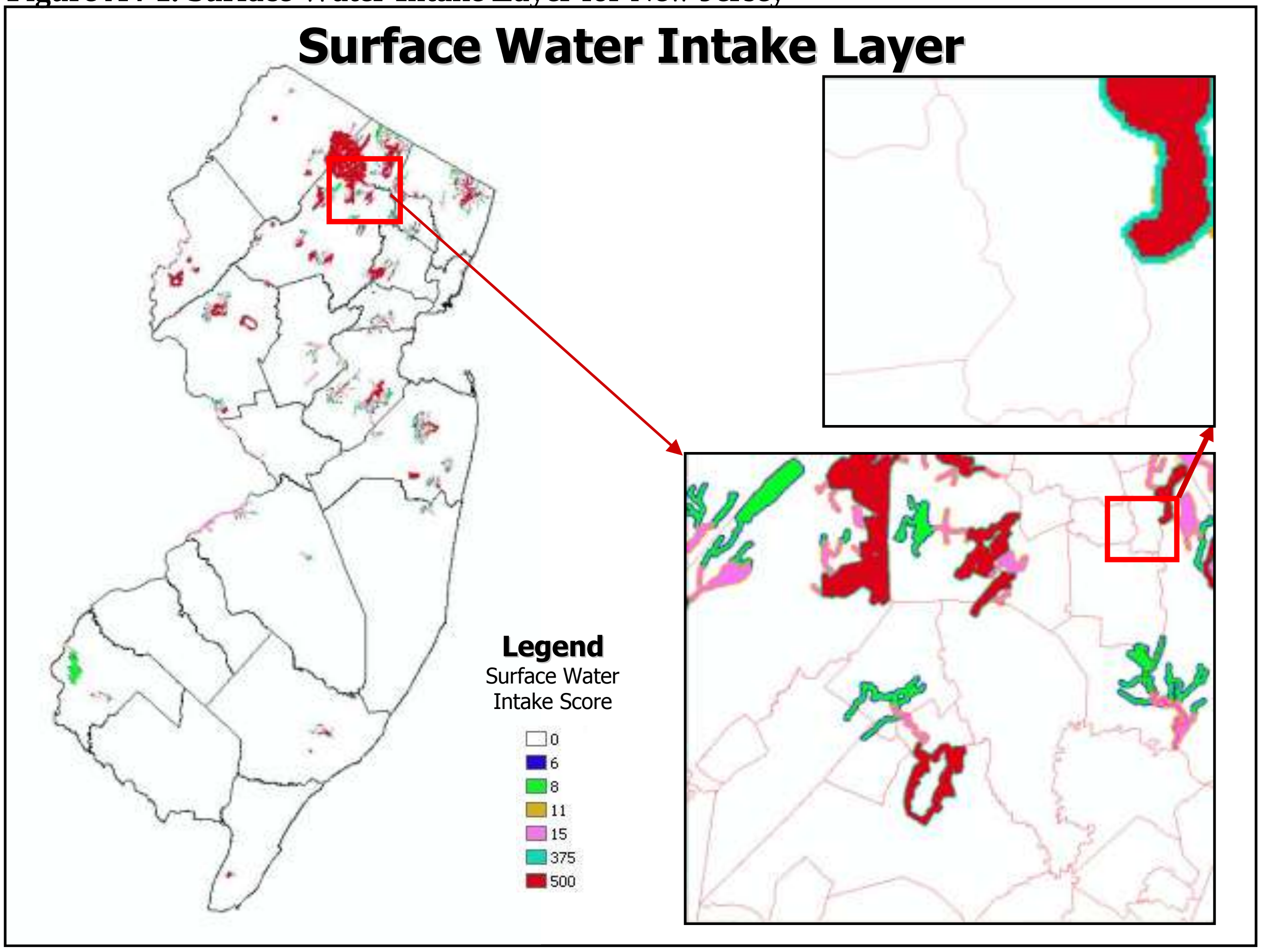
Table A4-1. Cell Values for the Surface Water Intake Layer

Surface Water Intake and Buffer	**Cell Value**
500-foot buffer 1 mile upstream with wetlands	6
300-foot buffer 1 mile upstream with wetlands	8
500-foot buffer 1 mile upstream on lake or stream	11

[9] Learn more at http://www.state.nj.us/dep/rules/adoptions/adopt_091221a.pdf

Table A4-1. Cell Values for the Surface Water Intake Layer	
Surface Water Intake and Buffer	**Cell Value**
300-foot buffer 1 mile upstream on lake or stream	15
300-foot buffer on watershed management area or intake	375
On watershed management area or intake	500

Figure A4-1. Surface Water Intake Layer for New Jersey



Receptor Score Calculation Method - To calculate the Receptor Score, the Surface Water Intake layer is overlain by the Ground Water Extent Area for the site. The maximum cell value that is within the Ground Water Extent Area is used since the cell values were assigned relative to the Public Supply Well layers, which are based on population served and not the population density.

Issues / Future Plans –

- All distances were measured “as the crow flies”, not in literal stream distance.
- Some Water Supply polygons are described as being for wellheads instead of surface water intakes but many of these have surface water intakes inside them.

A5. Water Body (Human Health)[10] (aka. Surface Water Quality standards)

Receptor Class: Human Health **Medium Type:** Surface Water

Mode of Exposure –The exposure pathway is through people coming into direct contact with contaminated surface water produced by overland flow or ground water baseflow. The exposure would mainly occur during recreational activities. The GIS layer attempts to delineate areas where surface water contamination could affect potable water sources, propagation of fish and wildlife, recreation, agricultural and industrial supplies, and navigation.

Background - These data are a digital representation of New Jersey's Surface Water Quality Standards (SWQS) in accordance with "Surface Water Quality Standards for New Jersey Waters" as designated in N.J.A.C. 7:9 B. The SWQS establish the designated uses to be achieved and specify the water quality criteria necessary to protect the State's waters. Designated uses include potable water, propagation of fish and wildlife, recreation, agricultural and industrial supplies, and navigation. These are reflected in use classifications assigned to specific waters. The GIS layer reflects the stream classifications and anti-degradation designations adopted as of October 16, 2006.

Cell Value Origins - Four new layers were created from the SWQS coverage based on antidegradation values for the following stream categories:

- ON - Outstanding National Resource Waters
- C1 - Category One: Protected from any measurable change in water quality because of ecological, recreational or fisheries.
- C2 - Category Two: A "default" designation that applies to all surface waters except those designated as ONRW or C1.
- DR - Delaware River

Each of these layers were intersected with land use areas described as water to give a better defined polygon coverage of water bodies classified by SWQS antidegradation value. The same was done with land use areas defined as wetlands resulting in four wetlands polygon layers with an antidegradation value. Each of these 12 layers (four each for streams, lakes and wetlands) were buffered by 300 feet and 500 feet. Each of these layers (now 24) were given an initial value and

[10] Learn more about New Jersey's Surface Water Quality Standards at http://www.nj.gov/dep/wms/bwqsa/swqs.htm

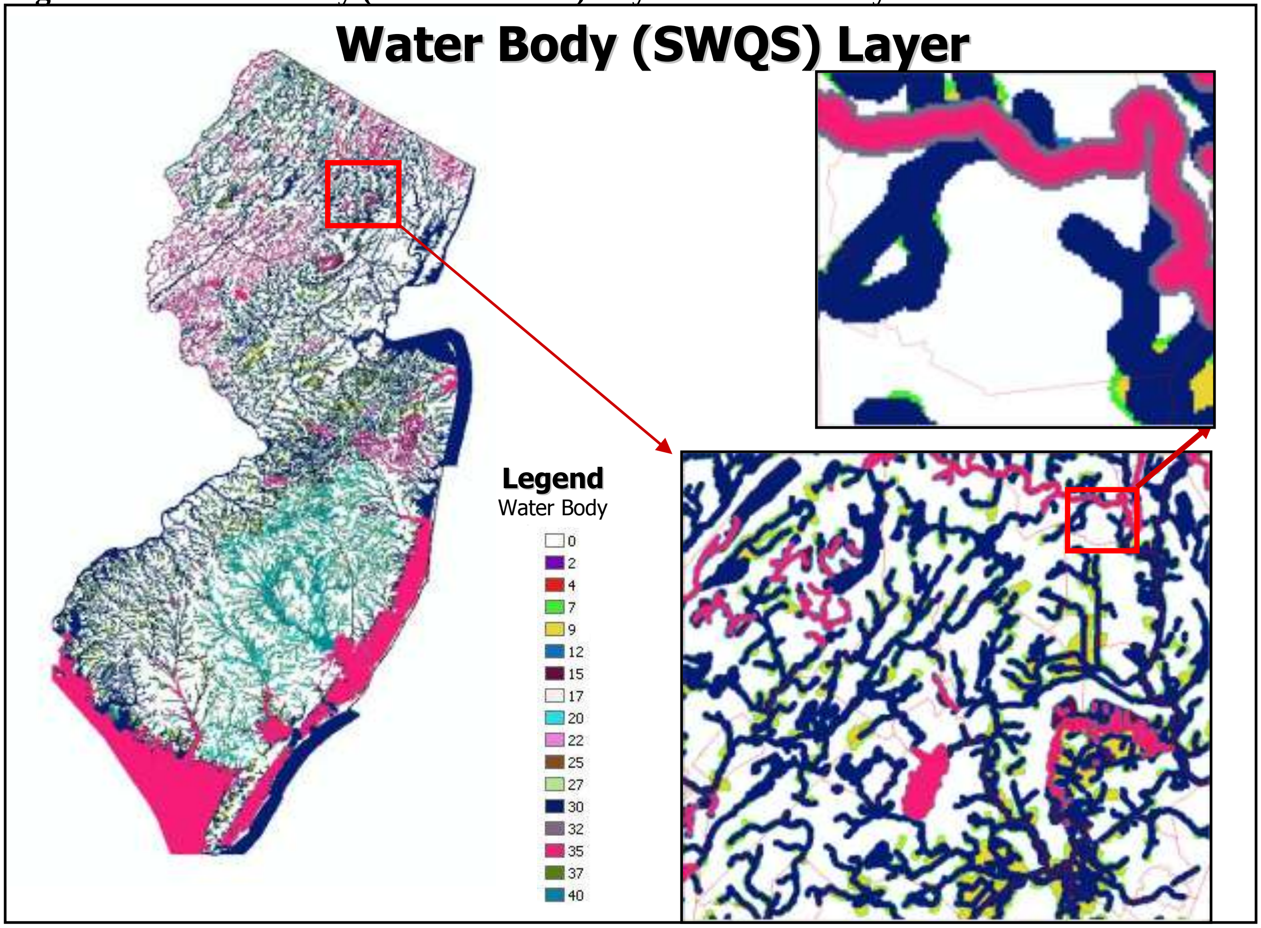
exported into a raster coverage. These 24 raster layers were combined into one composite raster file taking the maximum value from input grids.

A comparison was made between the Water Body layer and the Well layers, which are based on population and exposure duration. The cell values for the Water Body layer and the Surface Water Intake layer were then given an appropriate range in the RPS model based on relative risk of the Water Body in comparison to the Potable Well information. See Table A5-1 for the cell values for the Water Body layer. Figure A5-1 is the Water Body layer for the entire State used in the RPS model.

Table A5-1. Cell Values for the Water Body Layer (Human Health)

Surface Water Quality Standards	Cell Value
500-foot buffer on wetland = DR	2
300-foot buffer on wetland = DR	4
500-foot buffer on river = DR	7
300-foot buffer on river = DR	9
500-foot buffer on wetland = C-2	12
300-foot buffer on wetland = C-2	15
500-foot buffer on stream or lake = C-2	17
300-foot buffer on stream or lake = C-2	20
500-foot buffer on wetland = C-1	22
300-foot buffer on wetland = C-1	25
500-foot buffer on stream or lake = C-1	27
300-foot buffer on stream or lake = C-1	30
500-foot buffer on wetland = ON	32
300-foot buffer on wetland = ON	35
500-foot buffer on stream or lake = ON	37
300-foot buffer on stream or lake = ON	40

Figure A5-1. Water Body (Human Health) Layer for New Jersey



Receptor Score Calculation Method - To calculate the Receptor Score, the Water Body layer is overlain by the Ground Water Extent Area for the site. The maximum cell value that is within the Ground Water Extent Area is used since the cell value are assigned relative to the Public Supply Well layers, which are based on population served and not the population density.

Issues / Future Plans –

- All distances were measured "as the crow flies", not in literal stream distance.

A6. Agricultural

Receptor Class: Human Health **Medium Type:** Ground Water

Mode of Exposure –The pathway is through people eating agricultural products that have been exposed to contaminated ground water. Exposures could occur by several means, among them are: irrigation, transpiration or processing of food products. The GIS layer attempts to delineate areas where agricultural products may be produced.

Background – The Agricultural layer is a derived layer based on 1995 Land Use GIS coverage. Land use classes associated with Agriculture were identified.

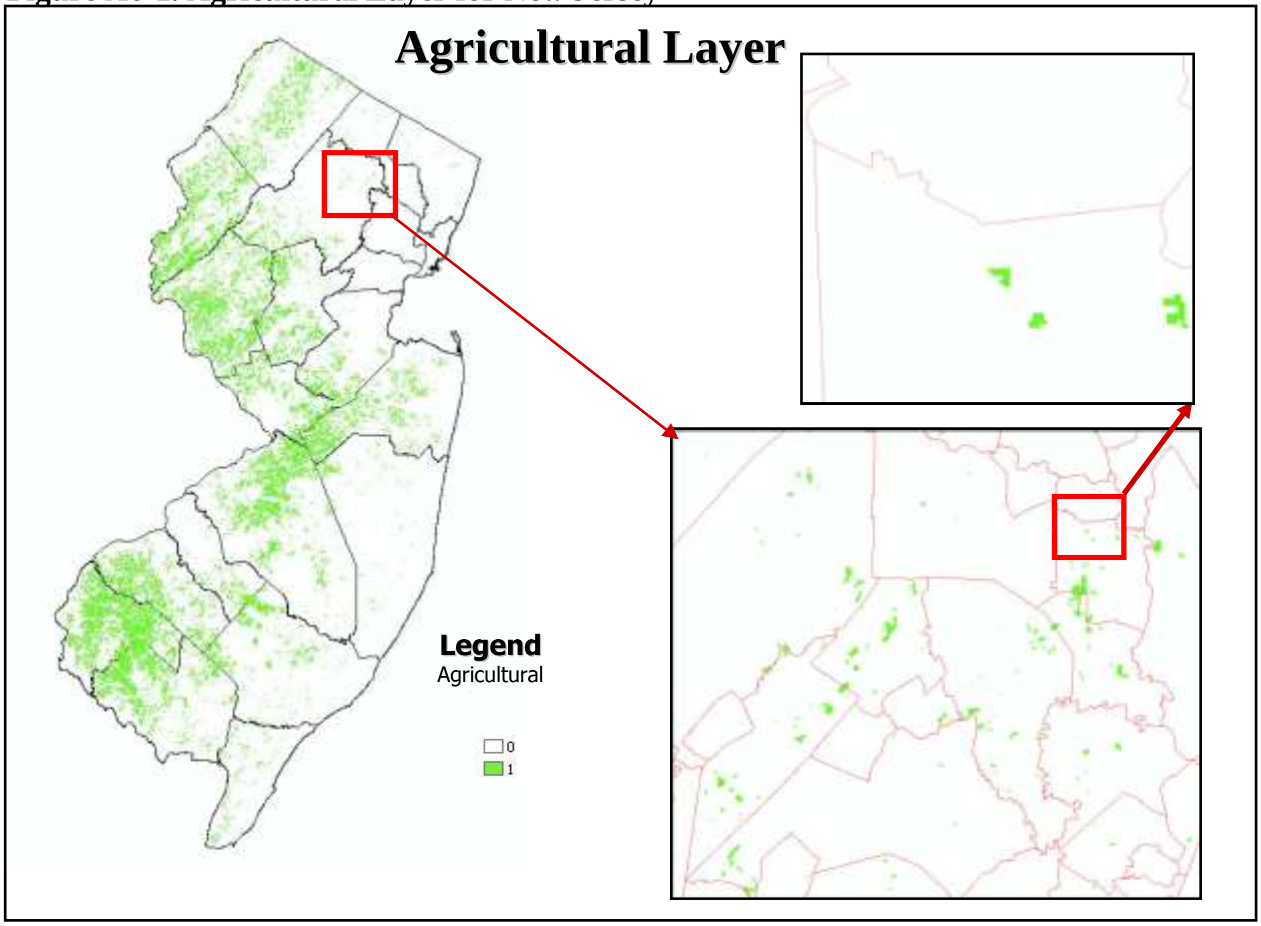
Cell Value Origins – A comparison was made between the Agricultural layer and the potable well layers, which are based on population and exposure duration. The Agricultural layer was then given an appropriate cell based on relative risk of the Agricultural in relationship to the potable well values. The cell values for each land use type are shown in Table A6-1. Figure A6-1 is the Agricultural layer for the entire State used in the RPS model.

Table A6-1. Cell Values for the Agricultural Layer

Land Use Type	Cell Value
Agricultural wetland, croplands, pastures, orchards, vineyards, horticulture, plantations, general agriculture	1
All other land use classes	0

Receptor Score Calculation Method - The Agricultural layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed since the cell values were assigned based on the agricultural density.

Figure A6-1. Agricultural Layer for New Jersey



Issues / Future Plans –

- Not all agricultural land use would have a potential for a ground water exposure.
- The Land Use layer is several years out of date and may count more Cells than are being farmed. According to United States Department of Agricultural (2012), the amount of total farm land in New Jersey has been reduced by approximately 15% since the Land Use layer was created.

A7. Soil Exposure: Residential Layer

Receptor Class: Human Health **Medium Type:** Soil

Mode of Exposure –The exposure pathway is the potential for people to be exposed (dermal / ingestion / inhalation) to contaminated soil at or near the site. The GIS layer attempts to identify the number of people that could be exposed to soil contamination at the site.

Background - The Soil Exposure: Residential layer is a derived layer based on population density calculated from the 1995 Land Use GIS coverage. Currently, the general population density is based on the statewide 2000 census values. To calculate the potential receptors for the site, the Soil Exposure: Residential layer adapted the United States Environmental Protection Agency's target distance limits described in the "Guidance for Performing Preliminary Assessments Under CERCLA." [11] The RPS model sets three target distance limits from areas of known or suspected contamination: 200 feet for the resident population threat, 1,700 feet for neighborhood threat, and 1 mile for the regional threat (Figure A7-1). The 200-foot and 1-mile target distance is consistent with the EPA Guidance and the neighborhood ring is based on the size of neighborhoods found in Camden, New Jersey (http://www.camconnect.org). These target distances create concentric rings or "zones" from the site so that the target population can be weighted for the different zones.

Figure A7-1. Target zones (Residential, Neighborhood, and Regional) used to calculate the Soil Exposure: Residential Layers used in the RPS Model

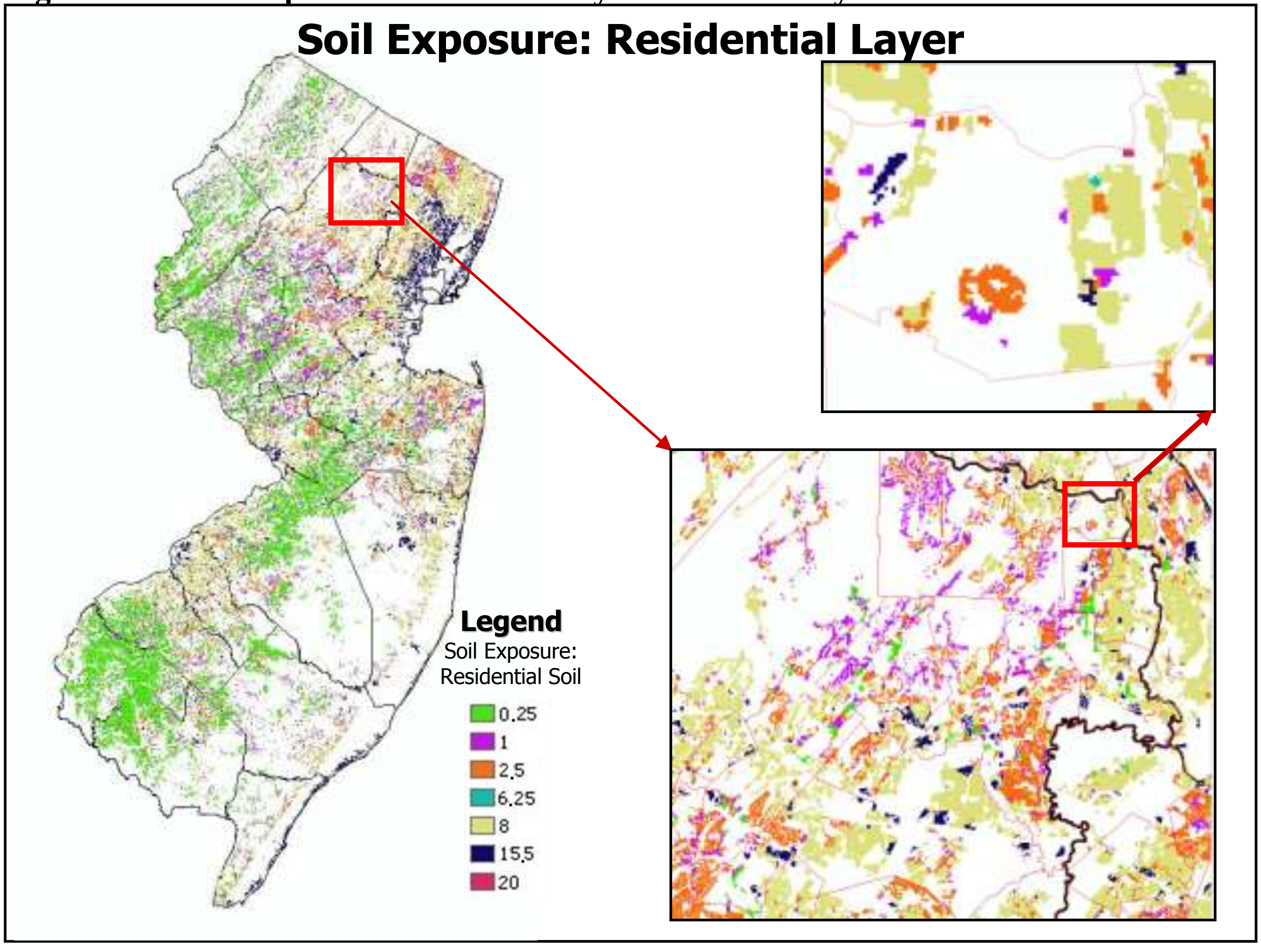
[11] (http://www.epa.gov/superfund/sites/npl/hrsres/pa/paguidance.pdf)

Cell Value Origins – Cell values are based on population density and exposure duration. The population density is calculated for land use types and the value for each type is derived from the 2000 census data. A 5 year exposure period is used to account for a theoretical time between the contamination being identified and completion of the Remedial Investigation phase. The value for each cell equals the population count per cell multiplied by five year exposure duration. The cell values for each land use type are shown in Table A7-1. Figure A7-2 is the Soil Exposure: Residential layer for the entire State used in the RPS model.

Table A7-1. Cell Values for the Soil Exposure: Residential Layer

Land Use Type	Cell Value
Agricultural wetland, croplands, pastures, orchards, vineyards, horticulture, plantations, general agriculture	0.25
Residential, rural, single units	1
Residential, single units, low density	2.5
Mixed residential	6.25
Residential, single units, medium density	8
Residential, high density, multiple dwellings	15.5
Mixed urban or built up land	20

Figure A7-2. Soil Exposure: Residential Layer for New Jersey



Receptor Score Calculation Method - In order to calculate the Receptor Score for the Soil Exposure: Residential layer, the RPS model buffers the Soil Extent Area for each of the zones (Site Zone, Neighborhood Zone and Regional Zone). To do this, the Soil Exposure: Residential layer is overlain by the three buffers for the site and the cell values (population multiplied by exposure duration) are summed for each zone. The cells are summed because the Values are based on population density. The summation of the cell values for each zone is then multiplied by the weighting factor to calculate a Scaled Zone value for that zone and then summed to arrive at a final layer score (figure A7-3 and figure A7-4). The factor for each of the zone is shown in Table A7-2.

Table A7-2. The Weighting factors for the three target distance limits (Zones)

Zone	Distance from site boundary	Weighting Factor
Site Zone	0-200 feet	1
Neighborhood Zone	200 to 1,700 feet	0.01
Regional Zone	1,700 to 5280 feet	0.001

Figure A7-3. Graphical representation of the Target Distance Limits used by the RPS Model.

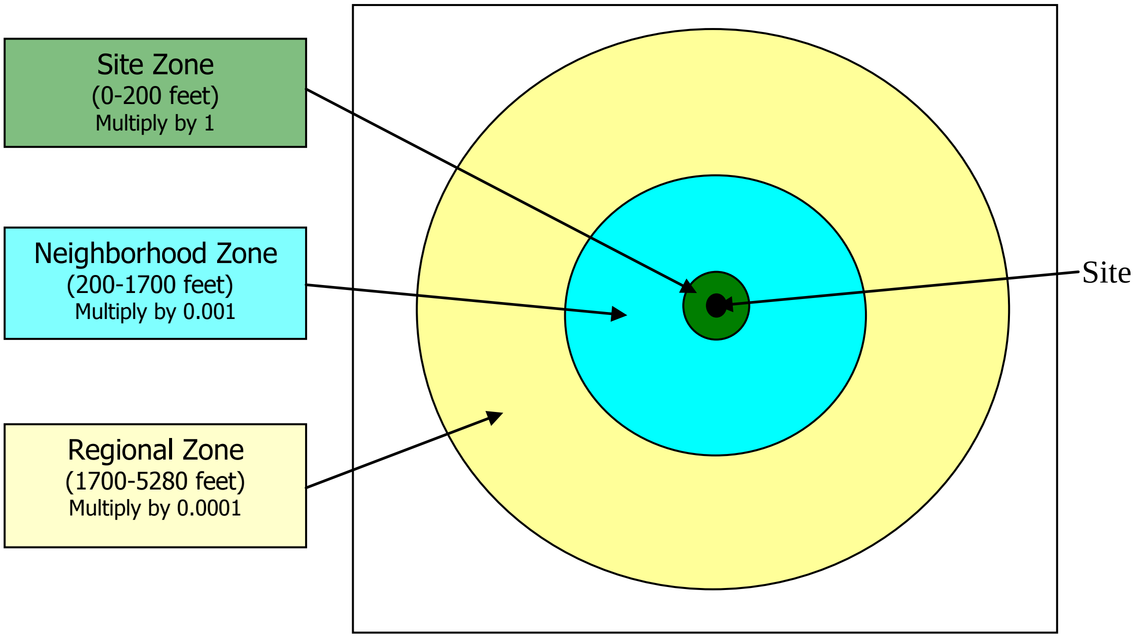
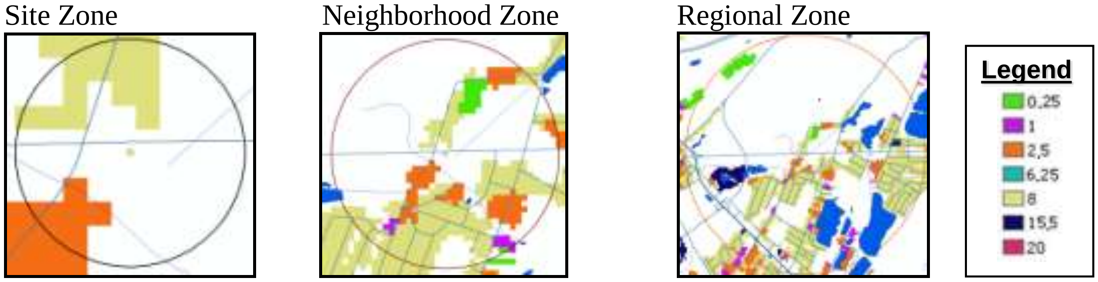


Figure A7-4. Steps to calculate the final Soil Exposure: Residential Score.

Zone Name: Site Zone | Neighborhood Zone | Regional Zone



	Site Zone	Neighborhood Zone	Regional Zone
Cell Total	103	2,554	17,368

Layer Value = **(Site Zone x 1.0)** **+ (Neighborhood zone x 0.01)** **+** **(Regional Zone x 0.001)**

Cell Total by Zone	103		2,554		17,368
Weighted Factor	x 1.0		x 0.01		x 0.001
Scaled Zone Value	103	+	25.5	+	17.4
Layer Value =	146				

Issues / Future Plans –

- Only calculates for residences and does evaluate business population.
- Newer data exists for both land use and census.

A8. Soil Exposure: School/Day Care Layer [12]

Receptor Class: Human Health **Medium Type:** Soil

Mode of Exposure – The exposure pathway is school and day care populations being exposed (dermal / ingestion / inhalation) to contaminated soil at or near the site. The GIS layer attempts to identify the number of people that could be exposed to soil contamination at the site.

Background - The Soil Exposure: Residential layer, previously discussed, only considers exposure to the residential population. Schools and day care facilities are excluded from this count. The Soil Exposure: School/Day Care layer specifically evaluates receptors at those facilities.

Cell Value Origins – Cell values are based on estimated School / Day Care Facility population and an exposure period. The value for each cell is equal to the estimated population for the entire facility, based on information provided by several sources including the National Center for Education Statistics web site (NCES, 2012). The RPS model uses a population of 500 to represent a school and 75 for a Day Care facility. A 5 year exposure period is used to account for a theoretical time between the contamination being identified and the completion of the Remedial Investigation phase. However, the exposure period for schools is adjusted to account for the 180-day school year. The exposure period for schools is 2.5 years.

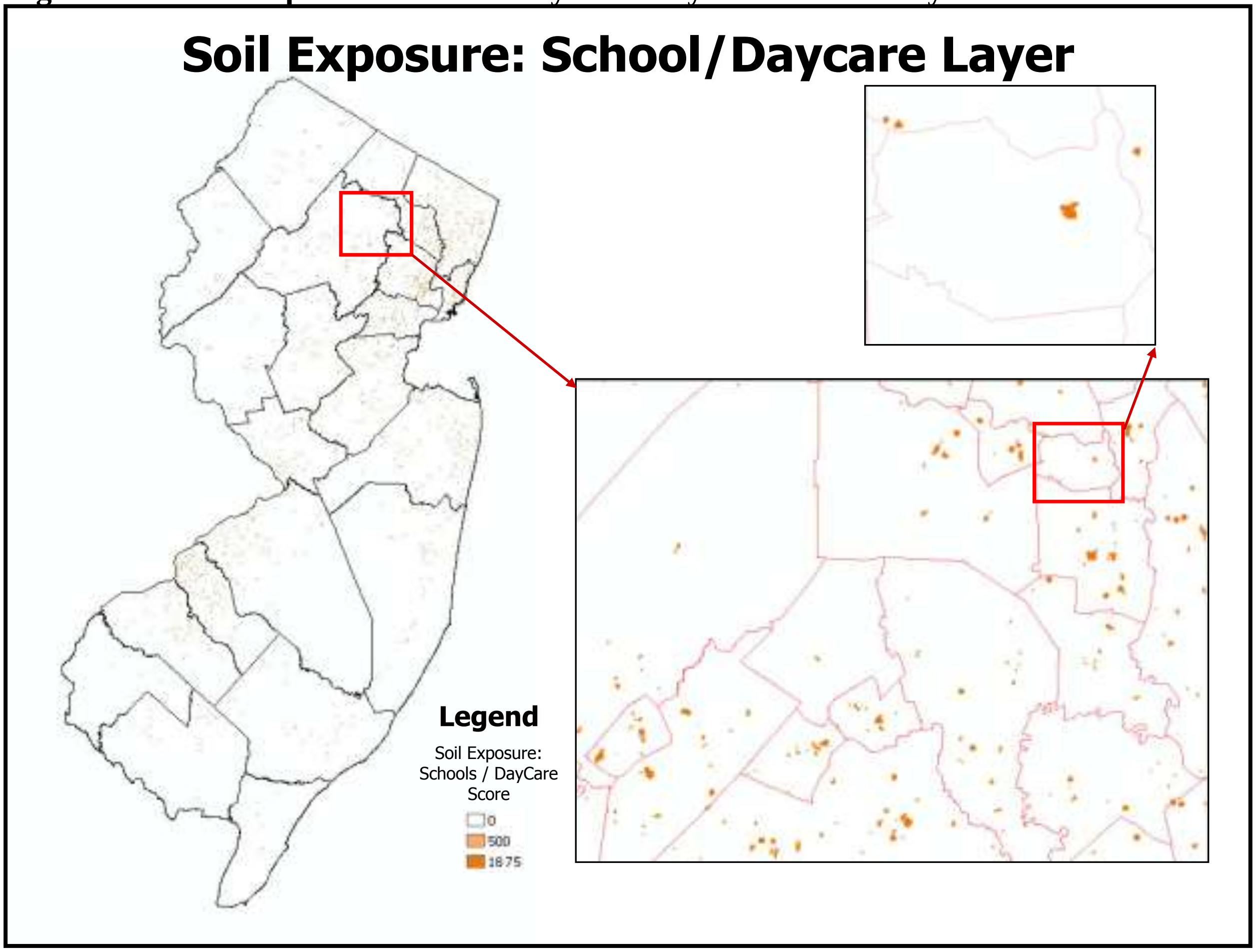
The value for each cell equals the population count per cell multiplied by exposure duration (2.5 years for school and 5 years for Day Care Facilities). The cell values are shown in Table A8-1. At this time, there is one layer, which is a union of the School and Day Care information. Figure A8-1 is the Soil Exposure: School Day / Care layer for the entire State used in the RPS model.

Table A8-1. Cell Values for the Soil Exposure: School / Day Care Layer

Type of institution	Cell Value
School	1250
Day Care Facility	375

[12] School Data Layer source: NJ Office of Information Technology, Office of Geographic Information Systems

Figure A8-1. Soil Exposure: School / Day Care Layer for New Jersey



Receptor Score Calculation Method - The Soil Exposure: School/Daycare layer is overlain by the Site zone buffer (200 feet) of the Soil Extent Area for the site. If there is a School within the Extent Area, then the Soil Exposure: School layer score is 1250. If there is a Day Care Facility, then the score for the Soil Exposure: Day Care layer is 375.

Issues / Future Plans –

- Need to create two distinct layers, one for Schools and one for Day Care Facilities to calculate the Receptor Layer Scores more efficiently.
- Does not count multiple day care facilities or schools
- Does not take into account toxicity variations based on age

A9. Vapor Exposure: Residential Layer [13]

Receptor Class: Human Health **Medium Type:** Vapor

Mode of Exposure –The exposure pathway is through people breathing volatile vapors that have accumulated in impacted structures through vapor intrusion. The GIS layer attempts to delineate the areas where vapors associated with ground water contamination could affect indoor structures.

Background – According to the SRP "Vapor Intrusion Technical Guidance" document, vapor intrusion (VI) is defined as the migration of volatile chemicals from the subsurface into overlying buildings. The presence of volatile organic compounds in soil or ground water offers the potential for chemical vapors to migrate through subsurface soils and along preferential pathways (such as underground utility lines), potentially affecting the indoor air quality of nearby buildings. The four main transport mechanisms that were evaluated are diffusion of vapors from sources in the unsaturated zone, diffusion of vapors from sources in shallow ground water, advective/convective transport of vapors, and vapor migration through preferential pathways. The RPS model is based on the "Decision Flow Chart for Vapor Intrusion Pathway" shown as Appendix A of the SRP "Vapor Intrusion Technical Guidance" document.

Cell Value Origins – Cell values are based on population density and exposure duration. The population density is calculated for land use types and the value for each type is derived from the 2000 census data. A 5 year exposure period is used to account for a theoretical time between the contamination being identified and completion of the Remedial Investigation phase. The value for each cell equals the population count per cell multiplied by five year exposure duration. The cell values for each land use type are shown in Table A9-1. Figure A9-1 is the Vapor Exposure: Residential layer for the entire State used in the RPS model.

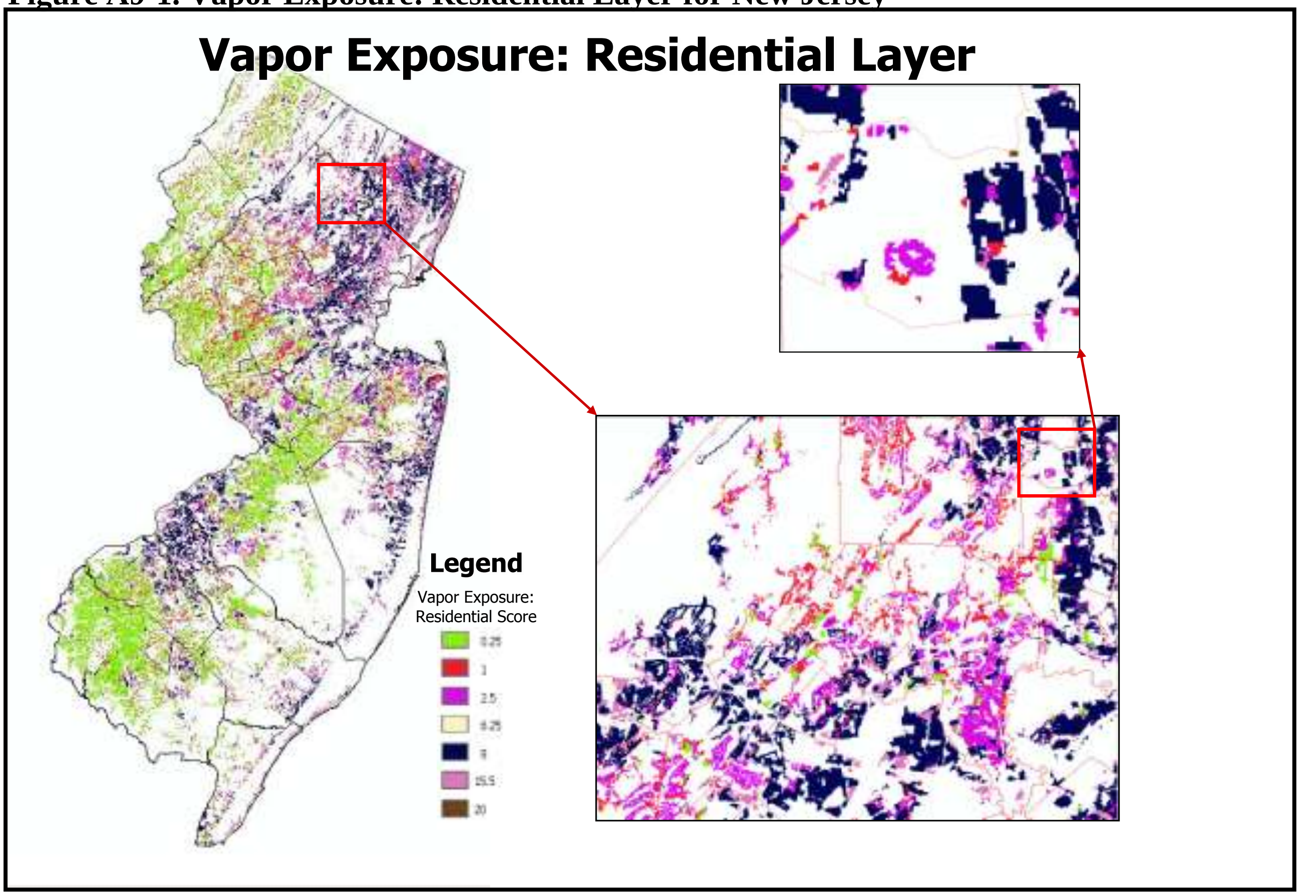
Table A9-1. Cell Values for the Vapor Exposure: Residential Layer

Land Use Type	Cell Value
Agricultural wetland, croplands, pastures, orchards, vineyards, horticulture, plantations, general agriculture	0.25
Residential, rural, single units	1

[13] Learn more about Vapor Intrusion at http://www.nj.gov/dep/srp/guidance/vaporintrusion/

Table A9-1. Cell Values for the Vapor Exposure: Residential Layer	
Land Use Type	**Cell Value**
Residential, single units, low density	2.5
Mixed residential	6.25
Residential, single units, medium density	8
Residential, high density, multiple dwellings	15.5
Mixed urban or built up land	20

Figure A9-1. Vapor Exposure: Residential Layer for New Jersey



Receptor Score Calculation Method - The Vapor Exposure: Residential layer is overlain by the Vapor Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed because the cell value is based on population density.

Issues / Future Plans:

- Does not count exposure at non-residential structures
- Newer data exists for both land use and census.

A10. Vapor Exposure: School/Daycare Layer [14]

Receptor Class: Human Health **Medium Type:** Vapor

Mode of Exposure –The exposure pathway is people breathing volatile vapors that have accumulated in impacted structures through vapor intrusion. The GIS layer attempts to delineate the areas where vapors associated with ground water contamination could affect indoor structures.

Background – According to the SRP “Vapor Intrusion Technical Guidance” document, vapor intrusion is defined as the migration of volatile chemicals from the subsurface into overlying buildings. The presence of volatile organic compounds in soil or ground water offers the potential for chemical vapors to migrate through subsurface soils and along preferential pathways (such as underground utility lines), potentially affecting the indoor air quality of affected buildings. The four main transport mechanisms that were evaluated are diffusion of vapors from sources in the unsaturated zone, diffusion of vapors from sources in shallow ground water, advective/convective transport of vapors, and vapor migration through preferential pathways. The RPS model is based on Stage 3 of the “Decision Flow Chart for Vapor Intrusion Pathway” shown as Appendix A of the SRP “Vapor Intrusion Technical Guidance” document.

Cell Value Origins – Cell values are based on estimated School / Day Care Facility population and an exposure period. The value for each cell is equal to the estimated population for the entire facility, based on information provided by several sources including the National Center for Education Statistics web site (NCES, 2012). The RPS model uses a population of 500 to represent a school and 75 for a Day Care facility. A 5 year exposure period is used to account for a theoretical time between the contamination being identified and the completion of the Remedial Investigation phase. However, the exposure period for schools is adjusted to account for the 180-day school year. The exposure period for schools is 2.5 years.

The value for each cell equals the population count per cell multiplied by exposure duration (2.5 years for school and 5 years for Day Care Facilities). The cell values for the Vapor Exposure: School/Daycare layer are shown in Table A10-1. Figure A10-1 is the Vapor Exposure: School / Day Care layer for the entire State used in the RPS model.

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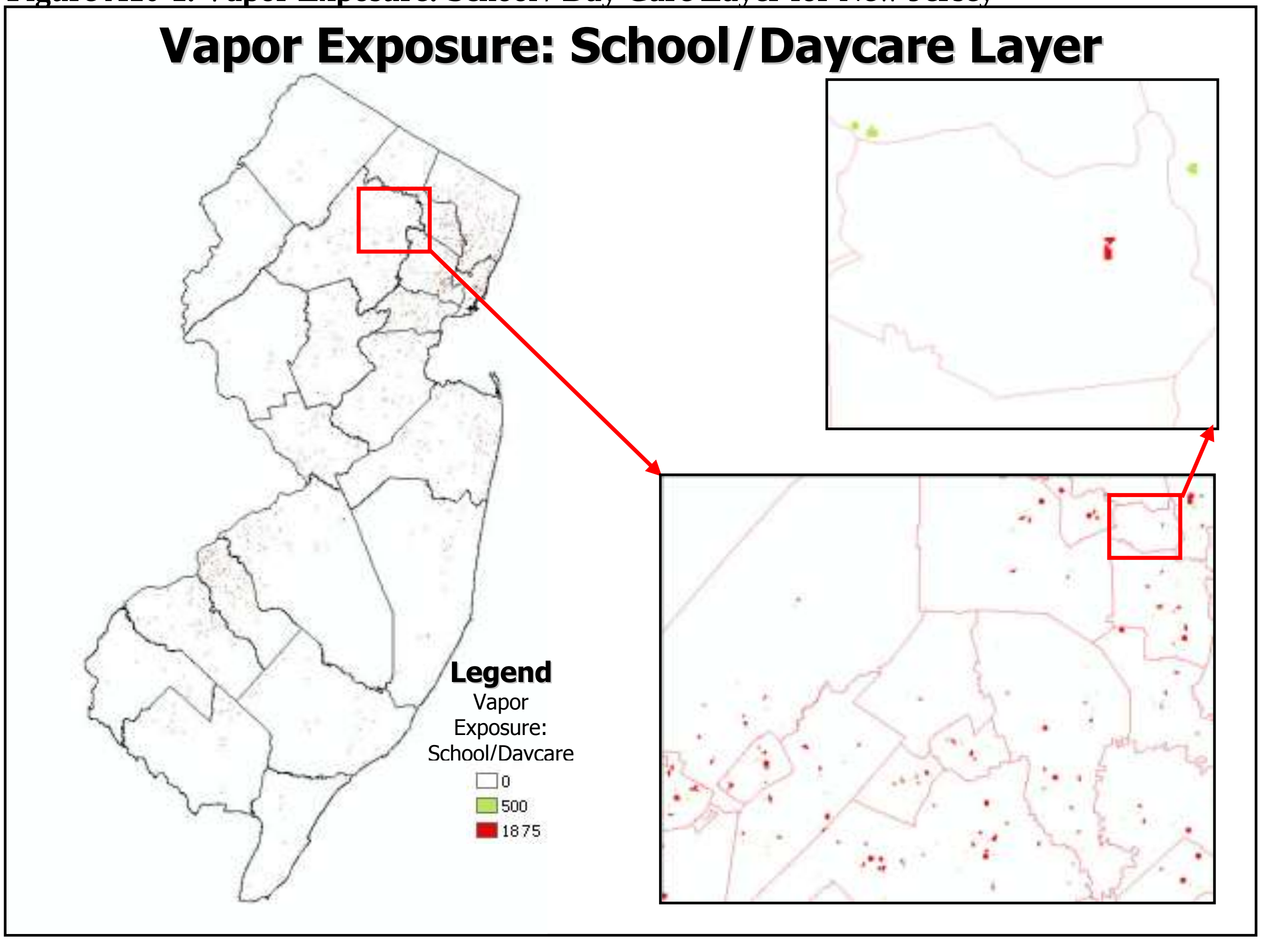
[14] Learn more about Vapor Intrusion at http://www.nj.gov/dep/srp/guidance/vaporintrusion/

Table A10-1. Cell Values for the Vapor Exposure: School/Daycare Layer	
Type of institution	**Cell Value**
School	1250
Day Care Facility	375

Figure A10-1. Vapor Exposure: School / Day Care Layer for New Jersey



Receptor Score Calculation Method - The Soil Exposure: School/Daycare layer is overlain by the Vapor Extent Area for the site. If there is a School within the Extent Area, then the Soil Exposure: School layer score is 1250. If there is a Day Care Facility, then the score for the Soil Exposure: Day Care layer is 375.

Issues / Future Plans –

- Need to create two distinct layers, one for Schools and one for Day Care Facilities to calculate the Receptor Layer Scores more efficiently.
- Does not count multiple day care facilities or schools
- Does not take into account toxicity variations based on age

Ecological Health Layers

A11. Pinelands [15]

Receptor Class: Ecological Health

Background – The Pinelands National Reserve (PNR) was created by Congress under the National Parks and Recreation Act of 1978. The PNR encompasses approximately 1.1 million acres covering portions of seven counties and all or parts of 56 municipalities. This internationally important ecological region occupies 22% of New Jersey's land area. It is the largest body of open space on the Mid-Atlantic seaboard between Richmond and Boston and is underlain by aquifers containing 17 trillion gallons of some of the purest water in the land.

The boundaries depicted in these layers are those adopted by the New Jersey State Legislature in accordance with the Pinelands Protection Act of 1979. The boundaries define the areas under state regulation as outlined in the Comprehensive Management Plan, which was developed as part of the act. The Pinelands Management Area Boundaries data are composed of polygons representing the Pinelands Management Area Boundaries in Southern New Jersey. The layer was created manually by interpreting a text document that described the boundary lines. The boundaries where then drafted on mylar using United States Geological Society photo quads as a base. In 1994, the data were digitized and converted to New Jersey State Plane North American Datum-83 (NAD-83) Feet. The current geometry is not static and is prone to change.

Cell Value Origins – The cell values were established to give weight to more critical and sensitive ecological receptors. Values were created to reflect inter-relationships between this layer and all other Ecological Receptor layers. The cell values for the Pinelands layer are shown in Table A11-1. Figure A11-1 is the Pinelands layer for the entire State used in the RPS model.

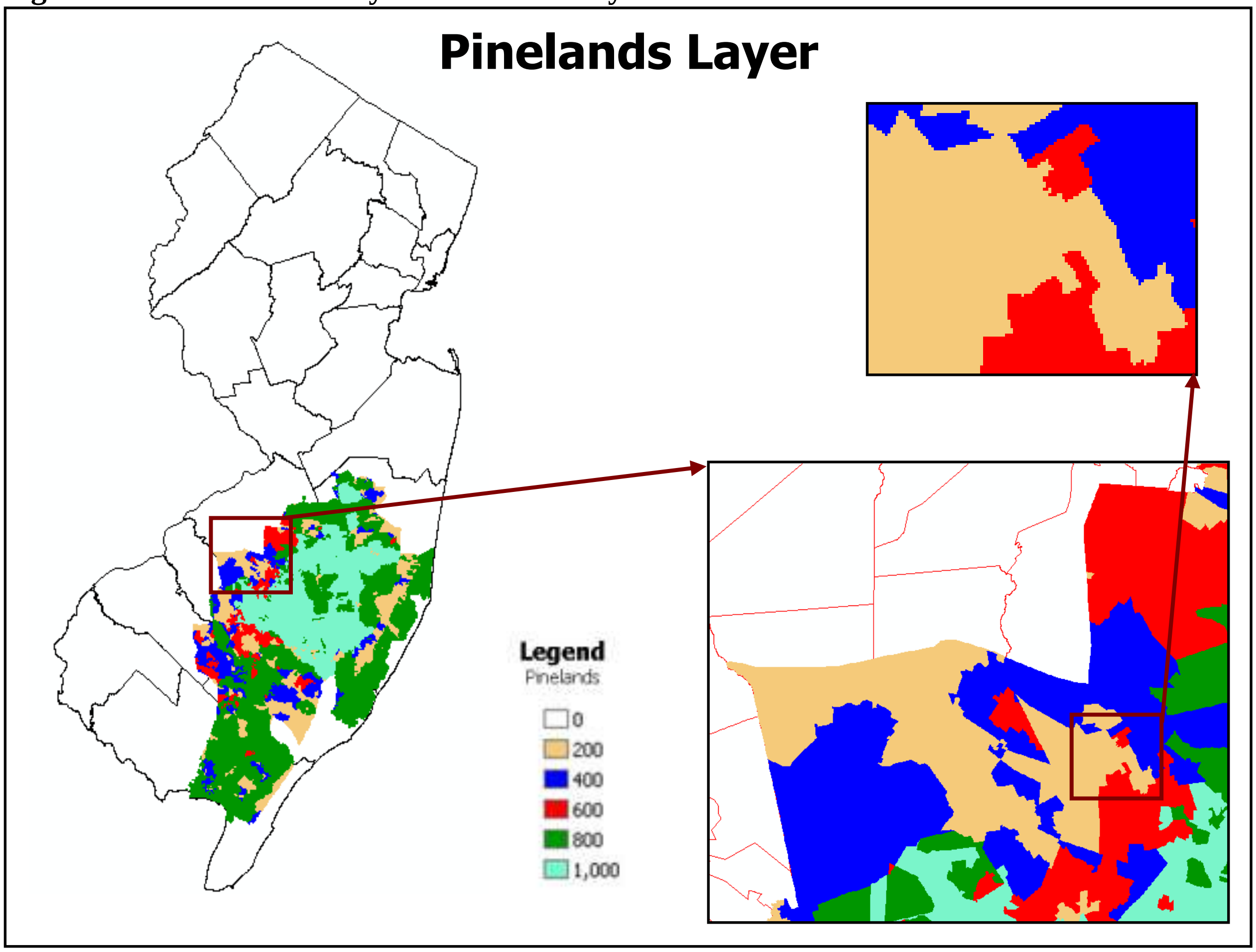
Table A11-1. Cell Values for the Pinelands Layers

Pinelands Management Area	Cell Value
Pinelands Town, Pinelands Village, Regional Growth Area	200

[15] Learn more at http://www.state.nj.us/pinelands/reserve/

Table A11-1. Cell Values for the Pinelands Layers	
Pinelands Management Area	**Cell Value**
Rural Development Area	400
Agricultural Production Area	600
Federal or Military Facility, Forest Area, Special Ag Production Area	800
Preservation Area	1000

Figure A11-1 Pinelands Layer for New Jersey



Receptor Score Calculation Method - The Pinelands Receptor layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed.

A12. Highlands [16]

Receptor Class: Ecological Health

Background – This dataset is an interpretation of the Highlands Preservation and Planning Area Boundary as described by the Highlands Water Protection and Planning Act of 2004. This dataset was created by utilizing the Highlands Parcel Base, the NJDEP Hydrography layer for 2002 and the New Jersey Department of Transportation Local Road Files as references to the act description.

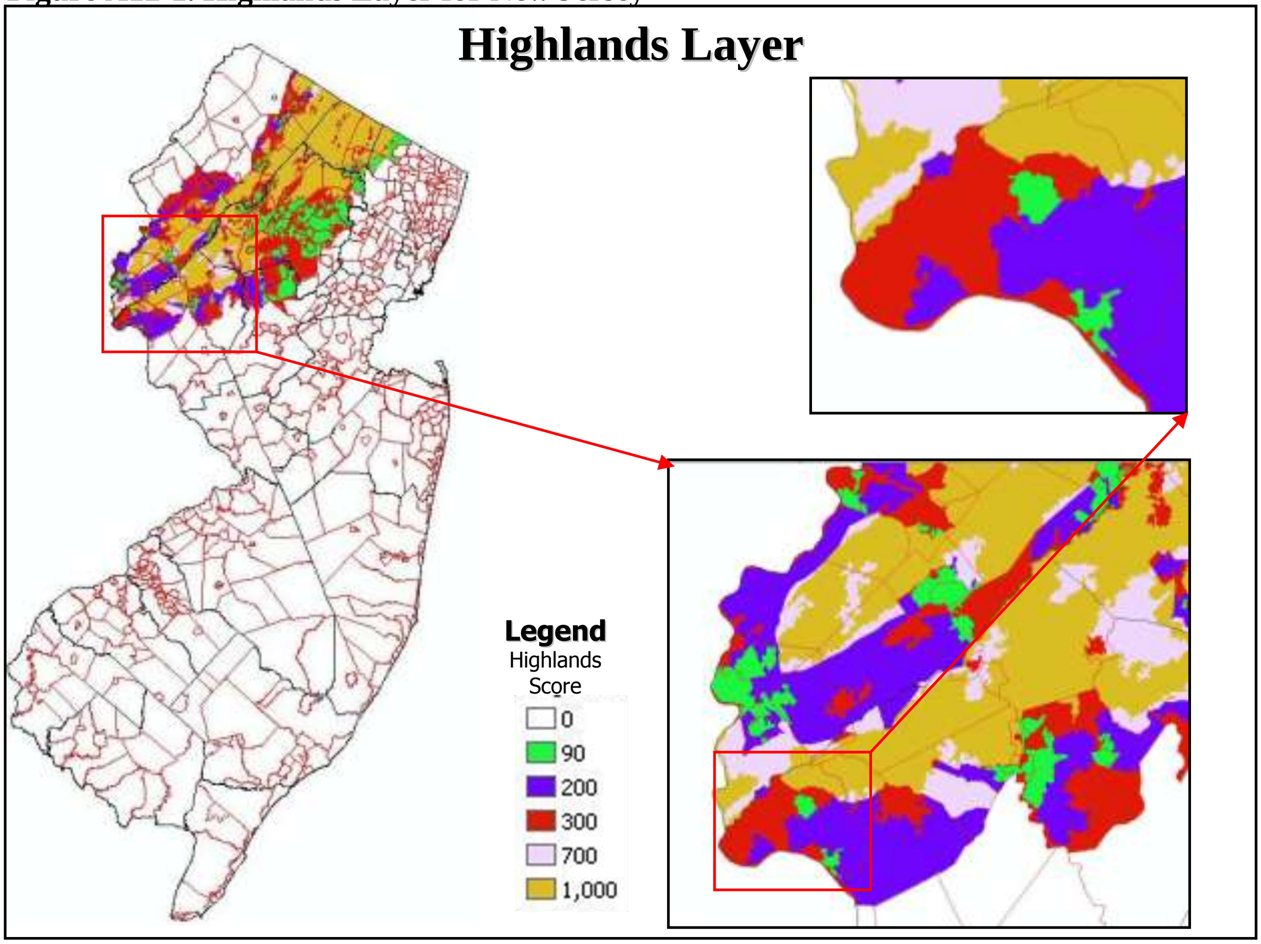
Cell Value Origins – The cell values were established to give weight to more critical and sensitive ecological receptors. Values were created to reflect inter-relationships between this layer and all other Ecological Receptor layers. The cell values for the Highlands layer are shown in Table A12-1. Figure A12-1 is the Highlands layer for the entire State used in the RPS model.

Table A12-1. Cell Values for the Highlands Layer

Highlands Preservation and Planning Area Boundary	Cell Value
Planned Community/Specially Planned Areas – Highlands Planning Area	90
Conservation – Highlands Planning Area	200
Planned Community/Specially Planned Areas – Highlands Preservation Area, Protection – Highlands Planning Area	300
Conservation – Highlands Preservation Area	700
Protection – Highlands Preservation Area	1000

[16] Learn more about the New Jersey Highlands at http://www.highlands.state.nj.us/

Figure A12-1. Highlands Layer for New Jersey



Receptor Score Calculation Method - The Highlands Receptor layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed.

A13. Water Body (Ecological) [17] *(aka Surface Water Quality Standards)*

Receptor Class: Ecological Health

Background – See the Surface Water Quality Standards background in Section 5 of Appendix A above.

Cell Value Origins – The cell values were established to give weight to more critical and sensitive ecological receptors. Values were created to reflect inter-relationships between this layer and all other Ecological Receptor layers. The cell values for the Water Body layer are shown in Table A13-1. Figure A13-1 is the Water Body layer for the entire State used in the RPS model.

Table A13-1. Cell Values for the Water Body Layer (Ecological Health)

Surface Water Quality Standards		Cell Values			
Anti Degradation	Category	300 foot	500 foot	300 foot Wetland	500 foot Wetland
DR	DRBC – Zone 5	300	230	150	110
DR	DRBC – Zone 4	400	300	200	150
DR	DRBC – Zone 3	500	380	250	190
DR	DRBC – Zone 2	500	380	250	190
DR	DRBC – Zone 1E	600	450	300	230
DR	DRBC – Zone 1D	600	450	300	230
DR	DRBC – Zone 1C	600	450	300	230
C2	SE3	300	230	150	110
C2	SE2	300	230	150	110
C2	SE1	300	230	150	110
C2	FW2 – NT / SE3	400	300	200	150
C2	FW2 – NT / SE2	500	380	250	190
C2	FW2 – NT / SE1	500	380	250	190

[17] Learn more about New Jersey's Surface Water Quality Standards at http://www.nj.gov/dep/wms/bwqsa/swqs.htm

Table A13-1. Cell Values for the Water Body Layer (Ecological Health)					
Surface Water Quality Standards		**Cell Values**			
Anti Degradation	**Category**	**300 foot**	**500 foot**	**300 foot Wetland**	**500 foot Wetland**
C2	FW2 – NT	600	450	300	230
C2	FW2 – TP	700	530	350	260
C2	FW2 – TM	800	600	400	300
C1	FW2 – NT / SE2	600	450	300	230
C1	FW2 – NT/SE1/SC	600	450	300	230
C1	FW2 – NT / SE1	600	450	300	230
C1	FW2 – NT	700	530	350	260
C1	FW2 – TP	800	600	400	300
C1	FW2 – TM	900	680	450	340
ON	FW1	800	600	400	300
ON	FW1 – TP	900	680	450	340
ON	FW1 – TM	900	680	450	340
ON	PL	1000	750	500	380
ON	PL – TM	1000	750	500	380

Description of the acronyms listed above:

Antidegradation Categories

ON - Outstanding National Resource Waters

C1 - Category One - Protected from any measurable change in water quality because of ecological, recreational or fisheries resources.

C2 - Category Two - A "default" designation that applies to all surface waters except those designated as Outstanding National Resource Waters (ONRW) or C1.

DR - Delaware River

Stream Classifications

DRBC - Delaware River Basin Commission

Zones 1,2,3,4 & 5 - The Delaware River is divided into five Zones

SE - Saline Estuarine Waters (3 Categories)

FW - Freshwater

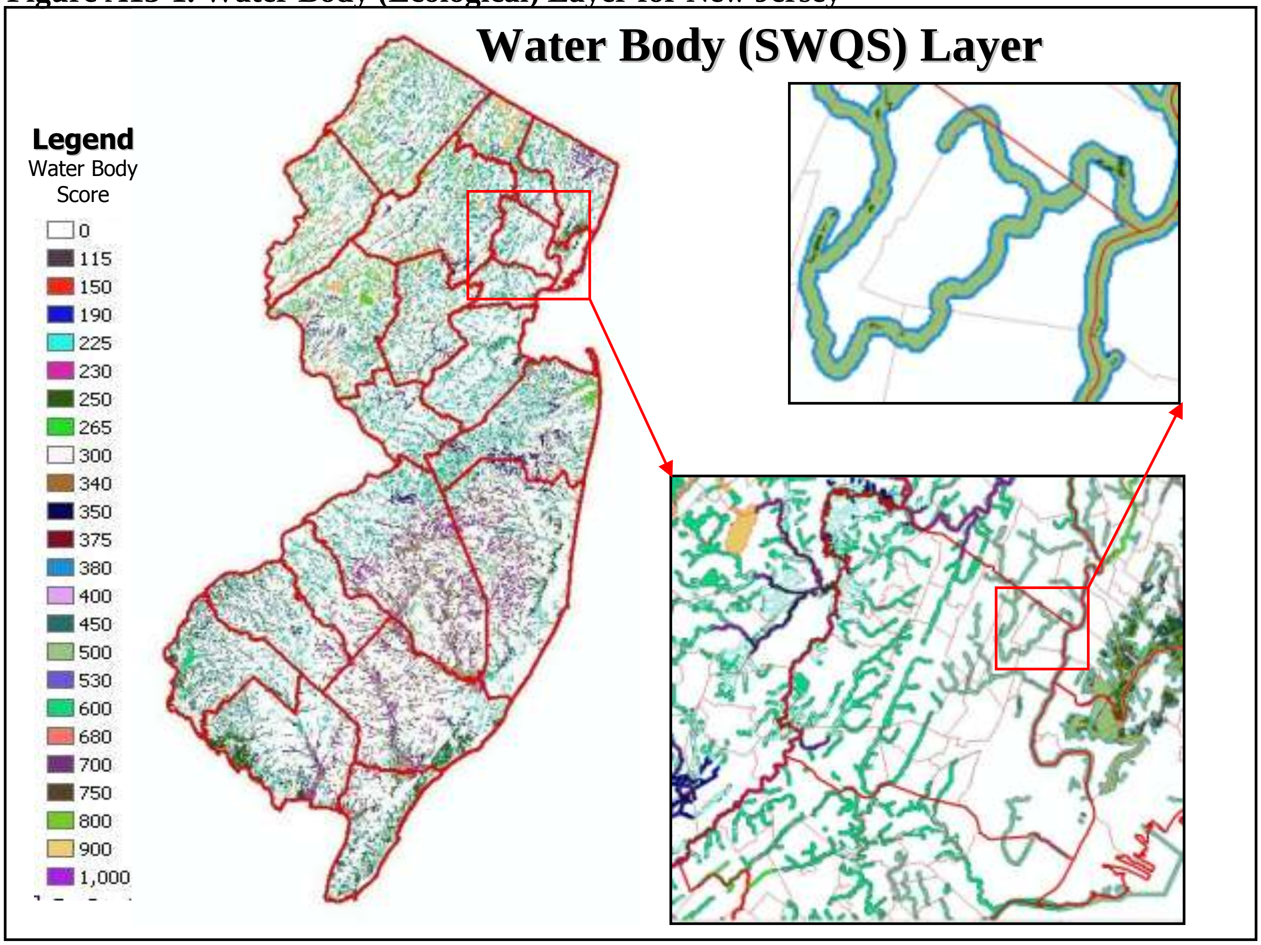
NT - Non-Trout

TP - Trout Producing

TM - Trout Maintenance

PL - Pinelands

Figure A13-1. Water Body (Ecological) Layer for New Jersey



Receptor Score Calculation Method - The Water Body (SWQS) Receptor layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed.

A14. Natural Heritage [18]

Receptor Class: Ecological Health

Background – The Natural Heritage Priority Sites coverage was created to identify the best habitats for rare plant and animal species and natural communities through analysis of information in the New Jersey Natural Heritage Database. Natural Heritage Priority Sites contain some of the best and most viable occurrences of endangered and threatened species and natural communities, but they do not cover all known habitats for endangered and threatened species in New Jersey. If information is needed on whether or not endangered or threatened species have been documented from a particular piece of land, a Natural Heritage Database search can be requested by contacting the Office of Natural Lands Management.

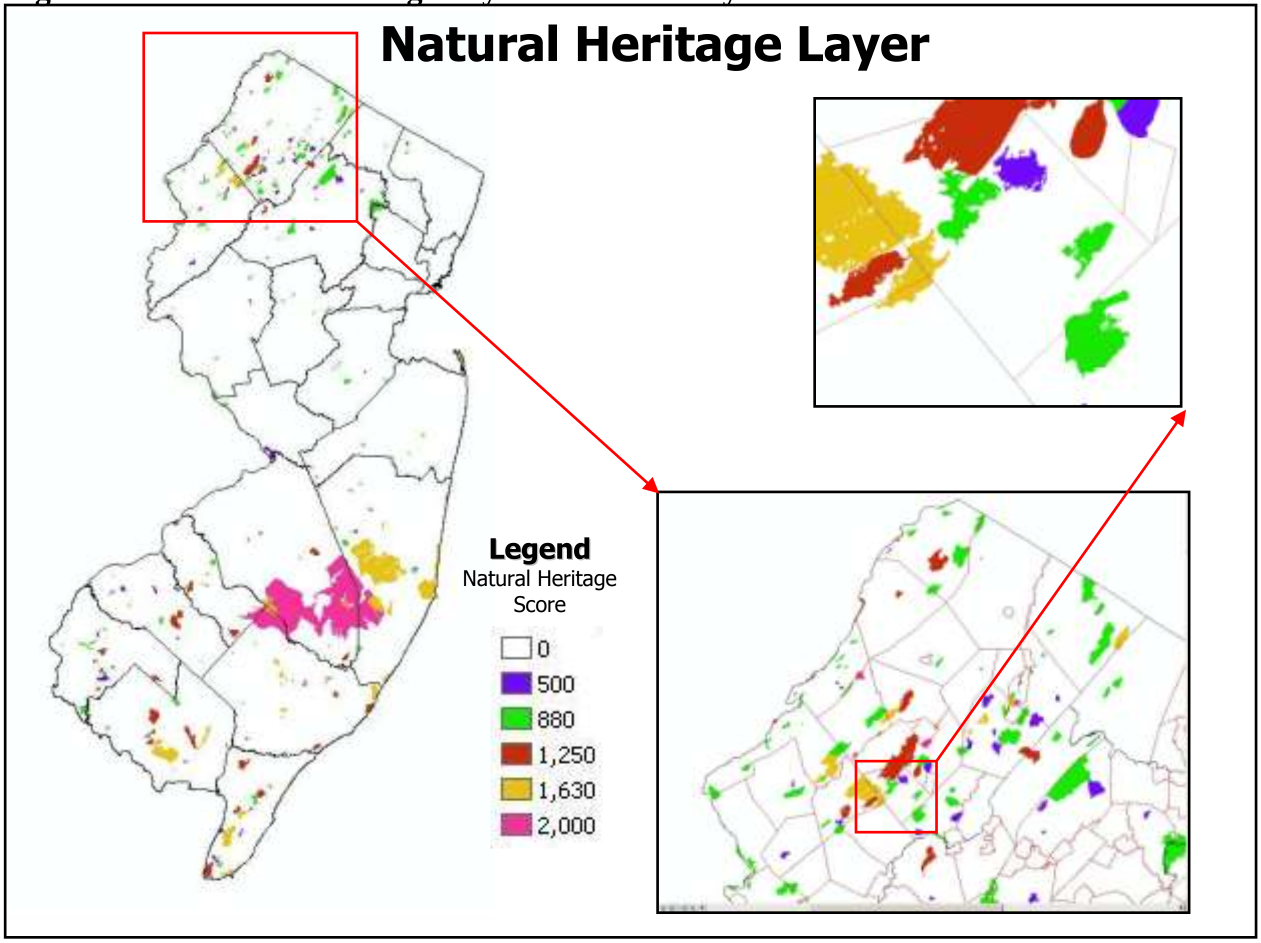
Cell Value Origins – The cell values were established to give weight to more critical and sensitive ecological receptors. Values were created to reflect inter-relationships between this layer and all other Ecological Receptor layers. Table A14-1 shows the cell values for the Natural Heritage Priority Sites. Figure A14-1 is the Natural Heritage layer for the entire State used in the RPS model.

Table A14-1. Cell Values for the Natural Heritage Layer

Natural Heritage Priority Sites	Cell Value
General significance ecological community	500
Moderate significance ecological community	875
High significance ecological community	1250
Very high significance ecological community	1625
Outstanding significance ecological community	2000

[18] Learn more about the Natural Heritage Program at http://www.nj.gov/dep/parksandforests/natural/heritage/

Figure A14-1. Natural Heritage Layer for New Jersey



Receptor Score Calculation Method - The Natural Heritage Receptor layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed.

A15. Landscape - Habitats and Animals [19]

Receptor Class: Ecological Health

Background – The RPS Model used the Landscape, Version 2 data to generate the Receptor layer. Version 3 was released on February 23, 2012, but could not be incorporated into this version of the RPS Model. The Landscape layer is managed by the N.J. Division of Fish and Wildlife. Information on the decision making process is outlined in the Landscape Project Version 2.1 Report[20].

The Landscape Project is a pro-active, ecosystem-level approach for the long-term protection of imperiled species and their important habitats in New Jersey. The N.J. Division of Fish and Wildlife's Endangered and Nongame Species Program (ENSP) began the project in 1994. Its goal: to protect New Jersey's biological diversity by maintaining and enhancing imperiled wildlife populations within healthy, functioning ecosystems.

The landscape data used in the creation of the Landscape 2.0 Critical Areas layer are based on version 2 of the Landscape Project habitat models, which utilize polygons from the NJDEP 1995/97 Land Use/Land Cover (LU/LC) data layer. In this process, appropriate LU/LC polygons were placed into one of the five basic habitat types modeled in the Landscape Project: Beach, Emergent Wetlands, Forest, Grasslands and Forested Wetlands. The landscape models were run to identify critical habitat areas within these habitats. Each polygon in each habitat layer is given a rank from 1 to 5, which reflects the critical nature of that habitat. Areas with Ranks 3, 4, or 5 are considered most critical since they represent habitat areas utilized by species on the State Threatened, State Endangered, and Federal Threatened and Endangered Species lists, respectively. The assignment of Rank is the same for all five habitats and is as follows:

- **Rank 5** is assigned to patches containing one or more occurrences of at least one wildlife species listed as endangered or threatened on the Federal list of endangered and threatened species.
- **Rank 4** is assigned to patches with one or more occurrences of at least one State endangered species.

[19] Learn more about the Landscape Project (Version 3) at http://www.nj.gov/dep/fgw/ensp/landscape/index.htm
[20] Learn more about Version 2 at http://www.state.nj.us/dep/fgw/ensp/landscape/lp_report_2_1.pdf

- **Rank 3** is assigned to patches containing one or more occurrences of at least one State threatened species.
- **Rank 2** is assigned to patches containing one or more occurrences of species considered to be species of special concern.
- **Rank 1** is assigned to patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened or priority wildlife species, but that do not intersect with any confirmed occurrences of such species.

In addition to the five habitat types, the Landscape Project data also includes separate layers for Peregrine Falcon, wood turtle and bald eagle foraging habitats.

The final Landscape score is a result of a three step process.

1. Convert the five habitats layers and the three distinct animal layers into 100- by 100-foot raster grid files using the Interim cell values listed in Table A15-1.
2. The eight layers are stacked and then summed to attain one resultant value for each cell.
3. Table A15-2 is used to reassign the cell value based on the summed cell value calculated in step 2.

Table A15-1. Initial Cell Values used to generate the initial final Landscape rankings

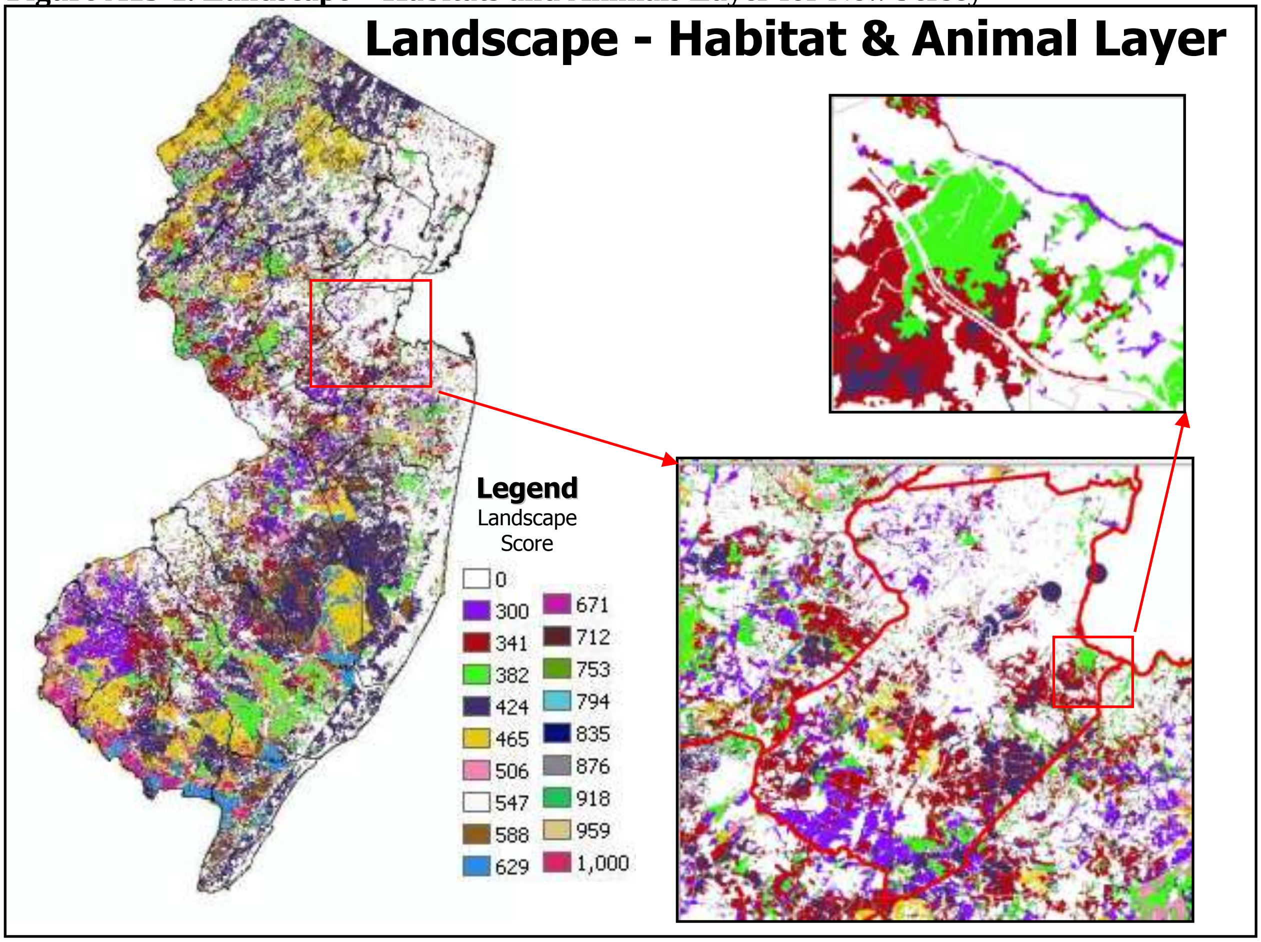
Habitat Type	Interim Cell Value
Habitat Types with a Rank of 5	5
Habitat Types with a Rank of 4	4
Habitat Types with a Rank of 3	3
Habitat Types with a Rank of 2	2
Habitat Types with a Rank of 1	1
Wood Turtle	3
Bald Eagle Foraging	5
Urban Peregrine Falcon	3

For example, a specific cell could have a Rank of 0 for Beach, Grasslands, Forested Wetlands, Forest and Urban Peregrine Falcon, but a rank of 3 for Emergent Wetlands, 3 for Wood Turtle and 5 for Eagle Foraging. The Summation of these layers is 11, which would be a final cell value of 712 as read from Table A15-2. Figure A15-1 is the Landscape layer for the entire State used in the RPS model.

Table A15-2. Cell Values for the Landscape Layer

Landscape Ranking	Cell Value
1	300
2	341
3	382
4	424
5	465
6	506
7	547
8	588
9	629
10	671
11	712
12	753
13	794
14	835
15	876
16	918
17	959
18	1,000

Figure A15-1. Landscape – Habitats and Animals Layer for New Jersey



Receptor Score Calculation Method - The Landscape – Habitats and Animals Receptor layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed.

A16. Freshwater Wetlands [21]

Receptor Class: Ecological Health

Background – Not all of the wetlands were identified by the Landscape Project. Those wetlands that were identified in the Land Use layer, but not included in the Landscape Project need to be identified. This layer identifies ecologically sensitive areas outside of the Landscape habitats that are designated as wetlands.

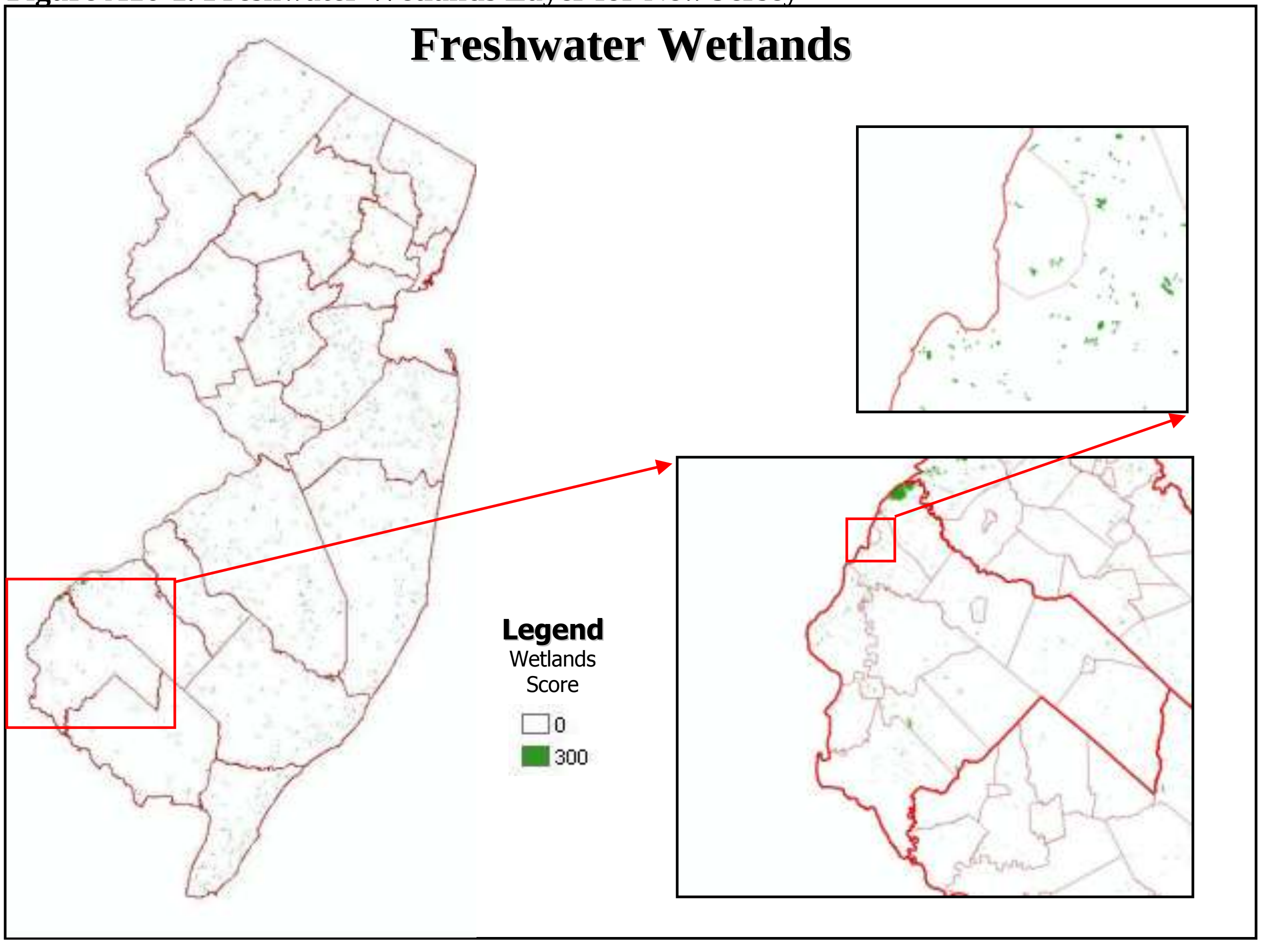
Cell Value Origins – The Land Use layer was rasterized into 100- by 100-foot grids identifying all wetlands land use types and then compared to the Rasterized Landscape Project Emergent Wetlands and Forested Wetlands layers. Those cells that were identified by the Land Use layer, but not the Landscape layers were given a score. The cell value was established to give weight to more critical and sensitive ecological receptors. The value was created to reflect inter-relationships between this layer and all other Ecological Receptor layers. The cell value for the Freshwater Wetlands layer is shown in Table A16-1. Figure A16-1 is the Wetlands layer for the entire State used in the RPS model.

Table A16-1. Cell Values for the Wetlands Layer

Land Use Type	Cell Value
wetlands outside of the Landscape layer	300

[21] Learn more at http://www.smartgrowthgateway.org/bio_info.shtml

Figure A16-1. Freshwater Wetlands Layer for New Jersey



Receptor Score Calculation Method - The Fresh Water Wetlands Receptor layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed.

A17. Salt Marshes [22]

Receptor Class: Ecological Health

Background – The Salt Marshes layer was derived by combining three 2002 Land Use layers. These layers are the saline high marsh, saline low marsh and "Phragmites dominates the coastal wetland" layers.

Salt marshes provide large areas of larval habitat for mosquito production. In the 1960's and 70's, as a means of reducing mosquito problems as well as restoring severely disturbed salt marsh habitat, several organizations within the state – including the NJDEP, Rutgers University, and county mosquito control organizations – developed and refined techniques for Open Marsh Water Management (OMWM). OMWM is a land management practice that restores salt marsh habitat that has been disturbed by human intervention through practices such as parallel grid ditching and salt hay farming, to a more natural environ while increasing tidal exchange on the marsh.

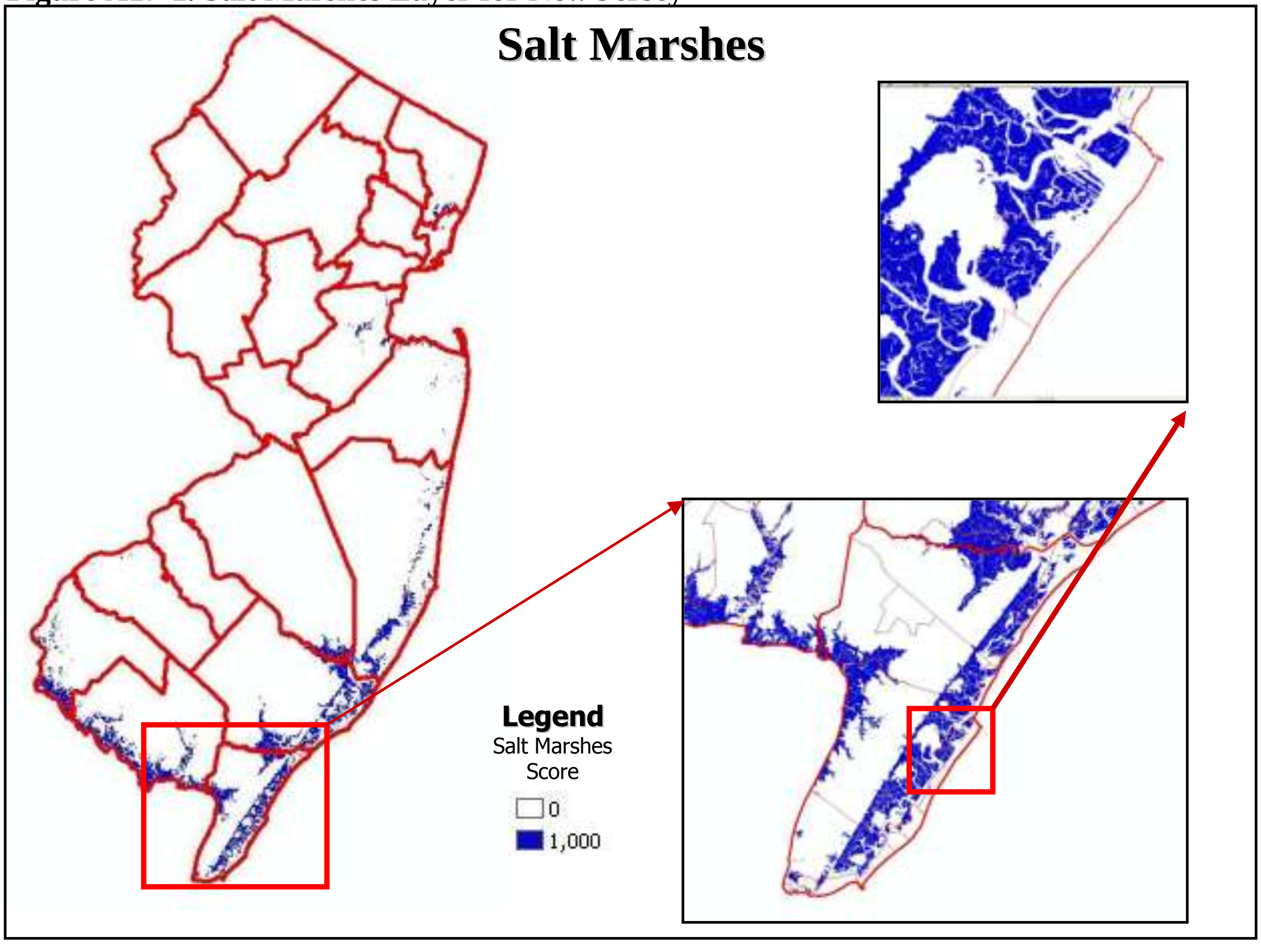
Cell Value Origins – The Land Use layer was rasterized into 100- by 100-foot grids identifying the land use types listed above and then compared to the Rasterized Landscape Project Emergent Wetlands and Forested Wetlands layers. Those cells that were identified by the Land Use layer, but not the Landscape layers were given a score. The cell value was established to give weight to more critical and sensitive ecological receptors. The value was created to reflect inter-relationships between this layer and all other Ecological Receptor layers. The cell value for the Salt Marsh layer is shown in Table A17-1. Figure A17-1 is the Wetlands layer for the entire State used in the RPS model.

Table A17-1. Cell Values for the Salt Marsh Layer

Land Use Type	**Cell Value**
Salt Marsh outside of the Landscape layer	1000

[22] Learn more at http://www.state.nj.us/dep/mosquito/docs/omwm_full.pdf

Figure A17-1. Salt Marshes Layer for New Jersey



Receptor Score Calculation Method - The Salt Marsh Receptor layer is overlain by the Ground Water Extent Area for the site. All cells values that are within the Ground Water Extent Area are summed.

Appendix B

Statistical Methodology

Equation NJDEP uses to calculate the UCL using a two-tailed Student t-test (Mendenhall, 1975)

$$\mu = \frac{\bar{y} + (t_{\alpha/2}) \times s}{\sqrt{n}}$$

Where: μ = Population Mean

$\bar{y}$ = Sample Mean

s = Standard Deviation

t_{α} = Value from T-table

Appendix C

GIS Terminology [23]

ArcView - Full-featured geographic information system software for visualizing, analyzing, creating, and managing data with a geographic component.

ArcView Shapefile - A vector data storage format for storing the location, shape, and attributes of geographic features. A shapefile is stored in a set of related files and contains one feature class.

dasymetric mapping - A method of thematic mapping, which uses areal symbols to spatially classify volumetric data. Dasymetric mapping is a preferred method to integrate census data with land use types. The United States Geologic Survey (USGS, 2012) states that "Dasymetric mapping depicts quantitative areal data using boundaries that divide the area into zones of relative homogeneity with the purpose of better portraying the population distribution."

dissolve - A geoprocessing command that removes boundaries between adjacent polygons that have the same value for a specified attribute.

geoprocessing - A geographic information system (GIS) operation used to manipulate GIS data. A typical geoprocessing operation takes an input dataset, performs an operation on that dataset, and returns the result of the operation as an output dataset. Common geoprocessing operations include geographic feature overlay, feature selection and analysis, topology processing, raster processing, and data conversion. Geoprocessing allows for definition, management, and analysis of information used to form decisions.

GIS - Acronym for *geographic information system*. An integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed.

[23] The GIS terminology was taken from the NJDEP GIS web site

The term *Geographical Information System* (GIS) is now used generically for any computer-based technique for the manipulation of geographical data. GIS is a broad field of endeavor, and incorporates the related fields of remote sensing and photogrammetry, as well as Global Positioning Systems (GPS). GIS includes not only hardware and software, but also the special devices used to manipulate geographic information to conduct spatial analysis and to create map products, together with communications systems needed to link various elements.

For more information, check out http://www.gis.com

union - A topological overlay of two or more polygon spatial datasets that preserves the features that fall within the spatial extent of either input dataset; that is, all features from both datasets are retained and extracted into a new polygon dataset.

Spatial Data - GIS data are often referred to as "spatial data" or "digital geospatial data." The term "geospatial" is derived from "geo" relating to the Earth, and "spatial" relating to location in space. Two broad categories of spatial data are known as "vector" and "raster". Beyond these main categories, other GIS-related data types include tabular data (database tables) and image data. All of these are discussed below.

Vector data layers are comprised of points, connecting lines and polygons are recorded digitally using X-Y coordinates. Such images are fully scalable meaning they can be enlarged and reduced in size for display without sacrificing detail. Most map layers in GIS are expressed as vector images in order to conserve digital storage space, accelerate retrieval and minimize work involving analytical processing.

Raster data layers are comprised of picture elements (pixels) that may be assigned a color value and intensity. An example of such images is a television picture. Raster images lose resolution (detail) as they are enlarged or reduced in size. These images usually occupy more storage space than vector images of the same area and require compression and expansion in use to conserve file space. Raster images usually result from the scanning process and in GIS are typically used for digitizing aerial photographs and background maps.

Tabular data, often referred to as **attribute data**, because it is information that describes the attributes of features in a data layer, is stored in database tables. Rather than describing location, tabular data provides the descriptive information about the features in a layer.

Image data or *Digital Imagery* is stored as raster data in a GIS and often provides an image as a backdrop to a vector data layer. Examples of image data include digital aerial photography, satellite imagery, scanned maps and photographs. Another term for image data commonly used is digital raster graphics (DRGs). USGS quadrangle topographic maps are often called USGS DRGs. Additional information on image data can be found in the Digital Imagery FAQs.

Appendix D

Example of RPS Scoring Sheet

Section I: Site Name: _________________ City / County: ________________
Case Tracking Number: _______ Preferred ID: ________ Activity: _________ Bureau: ____
Location: X Coordinate: ______ feet Y Coordinate: _______ feet

Section II: Human Health Category: ____

A. Water Medium Extent Area Shape: _____ Length: _______ GW Flow: ______ Default GW SCS: ____

1. Calculate the Receptor Scores *(Multiply each Receptor Score by the layer's Pathway Score)*

Receptor Layer	Layer Score		Pathway Score		Receptor Layer Score
Private Wells:	20	*Multiply by*	1	=	20
Community Wells:	1,300	*Multiply by*	1	=	1,300
Non-Community Wells:	0	*Multiply by*	1	=	0
Surface Water Intake:	300	*Multiply by*	1	=	300
Water Body (SWQS):	50	*Multiply by*	1	=	50
Agricultural:	0	*Multiply by*	1	=	0

2. Calculate the Ground Water (GW) Receptor Score *(Add up all of the Receptor Layer Scores)*

GW Receptor Score = 1,670

3. GW Site Condition Score (SCS)

GW SCS = 6.44

4. Calculate the medium score *(Multiply the GW Receptor Score by the GW SCS)*

GW Receptor Score: 1, 670
GW SCS: x 6.44
Water Medium Score = 10,755

B. Soil Medium Extent Area Type: ____________ Default Soil SCS: ____

1. Receptor Scores

Receptor Layer	Receptor Layer Score
Soil Exposure: Residential Soils	1,230
Soil Exposure: Schools	0
Soil Exposure: Day Care	0

2. Calculate the Soil Receptor Score *(Add up all of the Receptor Layer Scores)*

Soil Receptor score = 1,230

3. Soil Site Condition Score (SCS)

Soil SCS = 2.30

4. Soil Pathway

Soil Pathway Score = 1

5. Calculate the medium score *(Multiply the water medium score by the Site Condition Score by the Soil Pathway)*

Soil Receptor Score: 1,230
Soil SCS: 2.30
Soil Pathway: x 1
Soil Medium Score 2,829

C. **Vapor Medium** Vapor Buffer: ____________ Default Vapor SCS: ____

1. Receptor Scores

Receptor Layer	Receptor Layer Score
Vapor Exposure: Residential Soils	620
Vapor Exposure: Schools	0
Vapor Exposure: Day Care	0

2. Calculate the Vapor Receptor Score *(Add up all of the Receptor Scores)*

Vapor Receptor Score = 620

3. Vapor Site Condition Score (SCS)

Vapor SCS= 7.13

4. Vapor Pathway

Vapor Pathway Score = 1

5. Calculate the medium score *(Multiply the water medium score by the Site Condition Score by the vapor Pathway)*

Vapor Receptor score:	620
Vapor SCS:	7.13
Vapor Pathway:	x 1
Vapor Medium Score =	4,420

D. Human Health Receptor Class

1. **Calculate the medium score** *(Sum up the water medium score, the soil medium score, and the vapor medium score)*

Water Medium Score:	10,755
Soil Medium Score:	2,829
Vapor Medium Score:	+ 4,420
Human Health Score =	18,004

2. **Group sites into Categories**

Human Health category = 5

Section III: Ecological Health Category:

Extent Area Shape: _____ Length: _______ GW Flow: ______

1. Receptor Scores

Receptor Layer	Receptor Layer Score
Pinelands	0
Highlands	0
Water Body (SWQS)	6,300
Natural Heritage	0
Landscape	1,705
Wetlands	600
Salt Water Marsh	+ 0

2. Calculate the Ecological Receptor score *(Add up all of the Receptor Scores)*

Ecological Receptor score = 8,605

3. Ecological Pathway

Ecological Pathway Score = 1

4. Calculate the Ecological score *(Multiply the Ecological Receptor Score by the Ecological Pathway)*

Ecological Receptor score:	8,605
Ecological Pathway:	× 1
Final Ecological Score =	8,605

5. Group sites into Categories

Ecological Health Category = 2

Section IV: Submittals Received

Receptor Evaluation Form Received: _______________

EDDs Approved: Count: __ Directory: _____________________________________

Rejected: Count: __ Directory: _____________________________________

Appendix E

Feedback Loop Forms

New Jersey Department of Environmental Protection
Site Remediation Program

REMEDIAL PRIORITY SCORING (RPS) INFORMATION REQUEST FORM

SECTION A. Site Information

Site Name: ______________________________

Program Interest (PI) Number(s): ______________________

Case Tracking Numbers: ______________________

SECTION B. Information Request

I hereby request that the Department of Environmental Protection send me and/or my RPS contact additional information regarding the RPS Scoring for the above referenced site.

☐ Yes ☐ No

SECTION C. Location Correction

Location is Correct? ☐ Yes ☐ No

If incorrect; the correct location for the site (in NJ State Plane Feet) is:

Easting (X-Coordinate): ☐ feet

Northing (Y-Coordinate): ☐ feet

Method: ☐

SECTION D. ELECTRONIC DATA DELIVERABLES

I am submitting EDDs to be reviewed .... ☐ Yes ☐ No

Note: All submittals shall be emailed to SRPEDD@dep.state.nj.us Submit one email for each sampling event and each email shall include a dtst.txt, hzsample.txt and hzresult.txt file.

RPS Information Request Form
Version 1.0 03/08/12

Page 1 of 1

Remedial Priority Scoring System

New Jersey Department of Environmental Protection
Site Remediation Program

REMEDIAL PRIORITY SCORING (RPS) FEEDBACK FORM

SECTION A. LOCATIONAL INFORMATION

Site Name: ____
Program Interest (PI) Number(s): _________________________
Case Tracking Numbers: ________________________________

Site Location

Location is correct □Yes □No
X Coordinate __________ feet
Y Coordinate __________ feet
Method __________

SECTION B. CASE STATUS

Soil

Soil contamination present at any time during investigation? .... □Yes □No □Not Investigated
If "Yes," has soil contamination been delineated to the applicable Direct Contact Soil Remediation Standard? .... □Yes □No
If "Yes," are all soils either below Direct Contact Criteria or under an institutional control (i.e. deed notice.. □Yes □No

Ground Water

Ground Water (GW) contamination present? .... □Yes □No □Not Investigated
If "Yes," has GW contamination been delineated to the applicable Remediation Standards? .... □Yes □No
If "Yes," has the ground water use evaluation been completed? .... □Yes □No

Vapor Intrusion

Contaminants present in ground water exceed Vapor Intrusion Ground Water Screening Levels that trigger a VI evaluation. .... □Yes □No □Not Investigated
If "Yes," has GW been delineated to Vapor Intrusion Ground Water Screening Levels? .... □Yes □No
If "Yes," has the vapor intrusion investigation been completed? .... □Yes □No

Ecological Evaluation

Was an Ecological Evaluation (EE) been conducted? .... □Yes □No
Do the results of an EE trigger an RI of ecological receptors? .... □Yes □No
Has a remedial investigation of ecological receptors been conducted? .. □Yes □No
If "Yes," has the Ecological Evaluation been completed? .... □Yes □No

Comments: ____

SECTION C. GIS INFORMATION

Extent Area: Modification Requested (check all that apply)
□ Ground Water □ Soil □Vapor

Ground Water Flow Direction __________

SECTION D. ELECTRONIC DATA DELIVERABLES

I am submitting EDDs to be reviewed... □Yes □No
If "Yes," answer the following questions:
Emailed a new EDD submittal .... □Yes □No
Emailed an EDD submittal that had previously been rejected .... □Yes □No
Attached a modification to the LocList Table .... □Yes □No
Attached a modification to the the HZSample and Hzsample files................ □Yes □No
Comments: ____

Appendix F

ACRONYMS

ρ	Bulk Density
AOC	Area of Concern
C1	Category One Waters
C2	Category Two Waters
CEA	classification exception areas
CPR	Contaminant, Pathway and Receptor
CRSSA	Rutgers University Center for Remote Sensing and Spatial Analysis
DR	Delaware River
DWSG	Division of Water Supply and Geoscience
EDD	Electronic Data Deliverable
ENSP	N.J. Division of Fish and Wildlife's "Endangered and Nongame Species Program"
ESRI	Environmental Systems Research Institute
f_{oc}	Fraction of Organic Carbon
GIS	Geographic Information System
GW	Ground Water
GW SCS	Ground Water Site Condition Score
GWQC	Ground Water Quality Criteria
GWQS	Ground Water Quality Standards
IEC	Immediate Environmental Concern
KCSNJ	Known Contaminated Sites in New Jersey Reports
LSRP	licensed site remediation professional.
LU/LC	Land Use/Land Cover
NCWSW	Non-Community Water Supply Wells
NAD-83	North American Datum-1983
n_e	Porosity
NFA	No Further Action
NJDEP	New Jersey Department of Environmental Protection
NJEMS	New Jersey Environmental Management System
OMWM	Open Marsh Water Management
ON	Outstanding National Resource Waters
PCWSW	Public Community Water Supply Wells
PNR	Pinelands National Reserve
PWS	public water system
R	Retardation Factor
RAO	Remedial Action Outcome
RE	Responsible Entity
RPS	Remedial Priority Scoring
SCS	Site Condition Score
Soil SCS	Soil Site Condition Score
SRP	Site Remediation Program
SRRA	Site Remediation Reform Act
SW	Surface Water

SWQS	Surface Water Quality Standards
$t_{1/2}$	Half life
UCL	upper confidence limit
VI	vapor intrusion
Vapor SCS	Vapor Site Condition Score
WHPA	Well Head Protection Areas

Appendix G

References

Freeze, R.A., and Cherry, J.A., 1979, Groundwater. Englewood Cliffs, NJ, Prentice-Hall, 604 p.

McMaster, Robert, 1997. "In Memoriam: George F. Jenks (1916-1996)". *Cartography and Geographic Information Science*. 24(1) p.56-59

Mendenhall, William, 1975, Introduction to Probability and Statistics. North Scituate, MA, Duxbury Press, 460 p.

NCES. 2012. "State Profiles" http://nces.ed.gov/nationsreportcard/states/, National Center for Education Statistics. 2009-2010 school year.

NJDEP. 2003. Guidelines for Delineation of Well Head Protection Areas in New Jersey, New Jersey Department of Environmental Protection, 2003, OFR 03-1.

NJDEP. 2011a. Remediation Standard, (N.J.A.C. 7:26), New Jersey Department of Environmental Protection, October 3, 2011

NJDEP. 2011b. Ground Water Quality Standards, (N.J.A.C. 7:9C), New Jersey Department of Environmental Protection, December 5, 2011

NJDEP. 2012. Vapor Intrusion Technical Guidance Document, New Jersey Department of Environmental Protection, January 2012

North, Matthew A. 2009. "A Method for Implementing a Statistically Significant Number of Data Classes in the Jenks Algorithm". 2009 Sixth International Conference on Fuzzy Systems and Knowledge Discovery.

Jenks, George F. 1967. "The Data Model Concept in Statistical Mapping". International Yearbook of Cartography 7: 186-190.

Johnson, P.C. and R.A. Ettinger. 1991. "Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings," *Environmental Science and Technology* **25:** 1445-1452.

USDA. 2012. "State Fact Sheets: New Jersey" http://www.ers.usda.gov/statefacts/NJ.htm, United States Department of Agricultural, April 13, 2012.

USEPA. 1995. Ground Water Issue: Light Nonaqueous Phase Liquids, United States Environmental Protection Agency, July 1995; EPA/540/S-95/500

USEPA. 1991. Guidance for Performing Preliminary Assessments Under CERCLA, United States Environmental Protection Agency, September 1991; EPA/540/G-91/013

USEPA. 2002. Use of First-Order Rate Constants for Monitored Natural Attenuation Studies, United States Environmental Protection Agency, November 2002; EPA/540/S-02/500

USGS, 2012. "Dasymetric Mapping: An Alternative Approach To Visually And Statistically Enhancing Population Density" http://geography.wr.usgs.gov/science/dasymetric/index.htm, United States Geologic Survey, 2012