

NJDEP COMPLIANCE AVERAGING



COMPLIANCE AVERAGING OVERVIEW

- More realistic determination of compliance based on exposure to an area, rather than a single point in space
- The concepts of averaged exposure and functional areas are built into the equations that were used to derive SRSs (DC and IGW)
- Applicable to both Direct Contact and IGW pathways
- **Generally applicable to RI/RA Phase. Compliance averaging soil gas and pesticides in soil allowed in the SI phase.**
- **AOC must be delineated horizontally and vertically via single point compliance prior to using compliance averaging.**
- Sampling must be biased toward contamination; cannot include samples outside the delineated zone of contamination. “Excessive sampling” is defined as more than minimum to complete delineation per N.J.A.C. 7:26E.



ARITHMETIC MEAN

- Less than or equal to 2 values; or less than or equal to 9 sample points
- Sum all sample values and divide by number of samples (mean)
- Non-detect results assumed as zero in calculation
- No functional area consideration
- Applies to RI and RA; SI can be used for soil gas and historic pesticides in soil.



FUNCTIONAL AREAS

- Fixed area approach to risk assessment – as opposed to fixed point
- More realistic approach to risk assessment over single-point exposure. Acknowledges that receptors do not spend all of their time at a single-point of exposure, but rather exposure is averaged over time between contaminated and non-contaminated areas
- Defines the area where a receptor exposure may occur
- Defines the spatial extent of data that will be utilized to complete compliance averaging assessment of exposure to COC.
- Functional areas (FAs) must be evaluated on a “worst case first” basis

FAs - EXPOSURE PATHWAY CONSIDERATIONS

Direct Contact Pathways

- Land use must be considered - Residential vs. Non-Residential
- For the ingestion-dermal and inhalation pathways, functional areas (FAs) represent the areas of typical residential and non-residential sites
- To the extent practicable, placement of the initial FA must be biased to the worst case COC concentrations.

Impact to Groundwater Pathway

- For the impact to ground water exposure pathway, the FA is based on the size of the AOC.
- The relevant dimension is the length of the AOC in the direction parallel to ground water flow. No constraint on the length of the AOC in the direction perpendicular to ground water flow.

FAs - SIZE CONSIDERATIONS

Ingestion-Dermal Pathway

- FA is quarter (0.25) acres for residential, and two (2) acres for non-residential
- The residential FA of 0.25 acres represents one-half of the residential lot size, and assumes ingestion of COCs occurs in the front or back yard of the residence.
- If more than one FA is necessary and the contaminated areas of the site cannot be divided evenly, the size of the final FA can be increased by up to 50 %

Inhalation Pathway

- FA is half (0.5) acre for residential, and two (2) acres for non-residential
- Basis of FA size - Appendix G of *Inhalation Exposure Pathway Soil Remediation Standards Basis and Background* (June 2008).
- If more than one FA is necessary and the contaminated areas of the site cannot be divided evenly, the size of the final FA can be increased by up to 50 %

FUNCTIONAL AREAS - SIZE CONSIDERATIONS - EXAMPLES

Residential site (FA = 0.25 acres), ingestion-dermal pathway

Site = 0.33 acre - **the entire site can be evaluated as one FA.**

Site = 1.1 acres - **requires four FAs, three being 0.25 acres, and fourth 0.35 acres**

Non-residential site (FA = 2.0 acres), ingestion-dermal pathway

Site = 2.3 acres - **the entire site can be evaluated as one FA.**

Site = 4.3 acres - **requires two FAs, the first being 2.0 acres, and the second 2.3 acres**

Residential site (FA = 0.5 acres), inhalation pathway

Site = 0.75 acres - **the entire site can be evaluated as one FA**

Site = 1.2 acres - **requires two FAs, the first being 0.5 acres, and the second 0.7 acres**

Non-residential site (FA = 2.0 acres), inhalation pathway

Site = 3.0 acres - **entire site can be evaluated as one FA**

Site = 4.3 acres - **requires two FAs, the first being 2.0 acres, and the second 2.3 acres**



FAs - SIZE CONSIDERATIONS – IGW PATHWAY

- **The FA for the IGW pathway is defined by the AOC size.**
 - Width is defined as the width of the AOC perpendicular to GW flow (infinite).
 - Length is part of the AOC parallel to GW flow (up to 100 feet*)
 - 100 foot length is assumed length in DAF equation utilized to derive the default IGWSSL from SWPE
- **For AOCs \leq 100 feet in length, 100 feet can be used as the FA length if:**
 - Elected to use the IGWSSL; or
 - Developed a site-specific IGWSRS using 100 ft length.
- **For AOCs $>$ 100* feet in length:**
 - Assuming use of default DAF (20), multiple FAs of 100 feet length can be utilized; however, placement of the first FA must be biased to the worst case COC concentrations; or
 - The entire delineated AOC can be the FA; however, a site-specific DAF and IGW standard must be calculated using the actual length of the entire AOC.
- **Delineated AOCs situated downgradient of each other whose total length (including gaps) does not exceed 100 feet can be combined into a single FA.**

FAs - SHAPE CONSIDERATIONS

Direct Contact Pathways

- Preferred shape of the functional area is that of a square/rectangle but can vary based on site configuration and contamination distribution.
- The length of the FA can be no more than four times the width

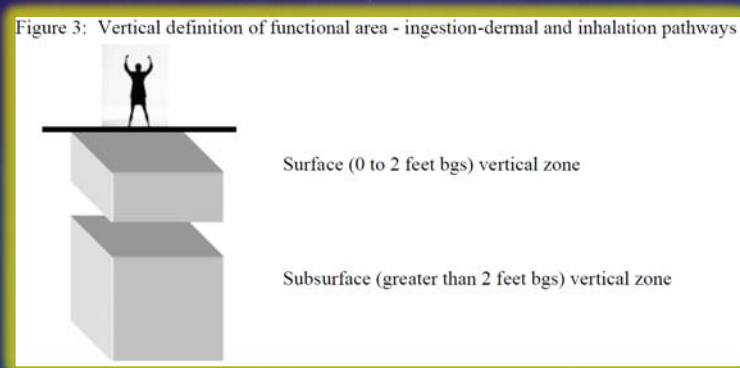
Impact to GW Pathway

- The shape of the FA is based on the shape/dimensions of AOC.
- The length of the AOC is the delineated distance in the direction parallel to ground water flow
- The width of the AOC is the delineated extent of contamination perpendicular to GW flow.

FAs - DEPTH CONSIDERATIONS

Direct Contact Pathways

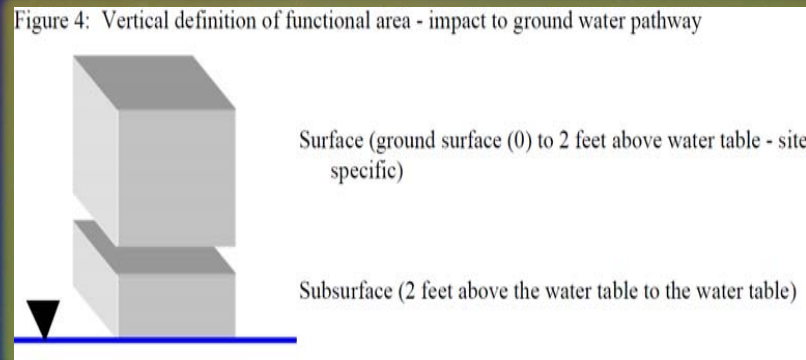
- Two zones: surface soil and subsurface soil; **must be evaluated separately**
- The surface zone will encompass both surface samples (0.0 to 0.5 feet) as well as any other samples taken at 2 feet of depth or less.
- The final vertical depth for the subsurface zone shall be determined pursuant to the delineation requirements set forth in N.J.A.C. 7:26E.



FAs - DEPTH CONSIDERATIONS

Impact to GW Pathway

- Two depth zones for the impact to ground water pathway:
 - Surface - ground surface to two (2) feet above the water table, and
 - Subsurface - two (2) feet above the water table to the water table
- Two foot zone above the water table zone was established to address fluctuations in the water table.



FAs - OFFSITE COMPLIANCE REQUIREMENTS

Direct Contact Pathways

- Contaminated offsite areas must be addressed through unique/separate FAs
- For DC pathways, if COCs have migrated offsite at any depth, delineation and compliance shall be to the most restrictive applicable standard - the unrestricted use standard (N.J.A.C. 7:26E-4.2(a)2).
- If FA compliance evaluation for the offsite contamination indicates no exceedances of the unrestricted use standard, then no further RA is required for the offsite contamination for the DC exposure pathways.
- Must evaluate worst case scenario first

Impact to Ground Water Pathway

- For the Impact to GW pathway, the FA is defined shape of the AOC, and is not affected by property boundaries. Offsite portions of contaminated areas are not required to be assessed through separate or unique FAs.

95% UPPER CONFIDENCE LEVEL OF THE MEAN

- Compliance averaging using 95 percent Upper Confidence Limit (95 UCL) can be conducted for all exposure pathways **during RI and RA Phases.**
- **Minimum of 10 samples required;** no maximum
- **Complete horizontal and vertical delineation** using single point compliance required before using 95 UCL.
- Pro UCL software is recommended; other software can be used, but must provide algorithm used and underlying assumptions with submittal.
- Requires use of FA approach.

95% UPPER CONFIDENCE LEVEL OF THE MEAN

- Data utilized must be that required to characterize and delineate the AOC. **No use of excessive samples or data from other AOCs**
- Each COC detected is evaluated by comparing the 95% UCL of the mean of COC versus the applicable standard.
- Surface (0-2) and subsurface (>2) data evaluated separately per FA guidance.
- If more than one potential UCL is identified, the lower value must be used in the evaluation.
- If the calculated UCL is greater than all values in the data set, the maximum sample value in the data set should be used for evaluation.



SPATIALLY WEIGHTED AVERAGING

- Compliance averaging using a weighted average approach; can be used for all exposure pathways in both the RI and/or the RA phases.
- May be defined/generated using Thiessen Polygons (also known as Voronoi or Dirichlet tessellations).
- Polygons define individual areas for averaging a set of data points.
- Thiessen polygons are polygons whose boundaries define the area that is closest to each point relative to all other points; they are mathematically defined by the perpendicular bisectors of the lines between all points.
- Results of each sample are applied over their respective polygon, and those results are weight-averaged based on area of the polygons to the whole FA.



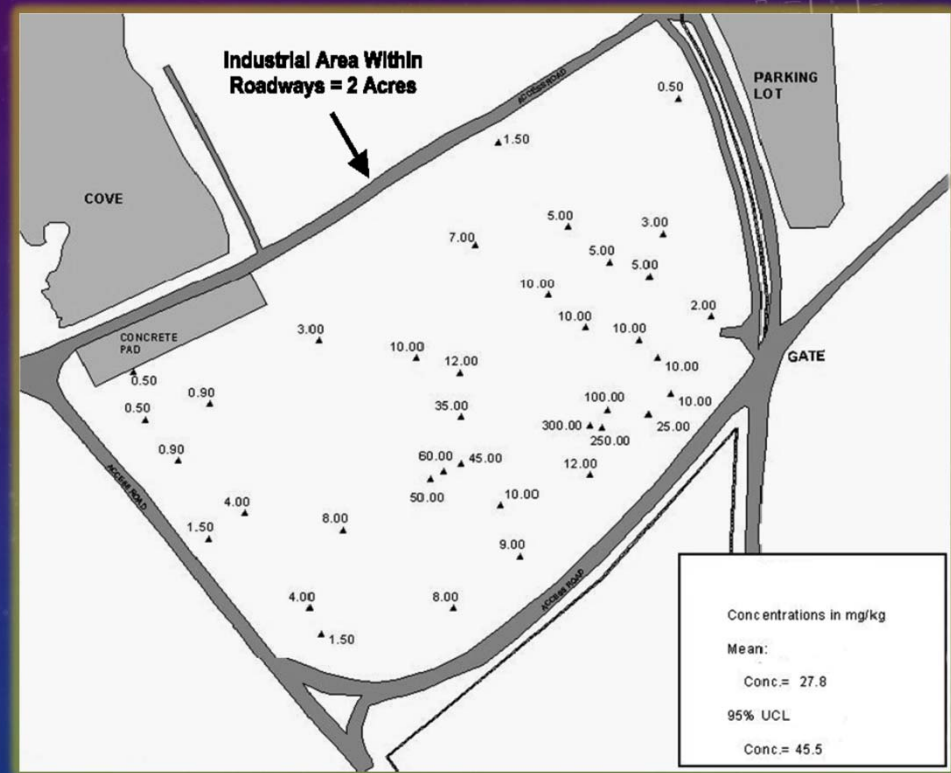
SPATIALLY WEIGHTED AVERAGING

- FA Size, Shape, Depth, and Off-Property Considerations still apply
- If multiple samples exist in a single vertical zone, the greatest concentration in that zone is to be used.
- Where multiple FAs are utilized, the first FA must be placed biased to the highest COC concentrations.
- Evaluation is an iterative analysis performed for each COC that exceeds a remediation standard
 1. Replace the most highly contaminated polygon with the fill (or background) concentration, and then recalculate the overall, area-weighted, mean concentration
 2. Continue with the next most contaminated polygon(s) until the area weighted mean for the FA is at or below the applicable remediation standard
 3. All polygons “removed” as part of this evaluation are required to be remediated.
- For unrestricted use, “removed” polygons would be remediated to the fill or background concentration used in the calculation of the area weighted mean concentration.



SPATIALLY WEIGHTED AVERAGING - EXAMPLE

- Industrial site approximately two (2) acres in size
- Applicable remediation standard is 8 mg/kg.
- For non-detect values, the reporting limit is used.



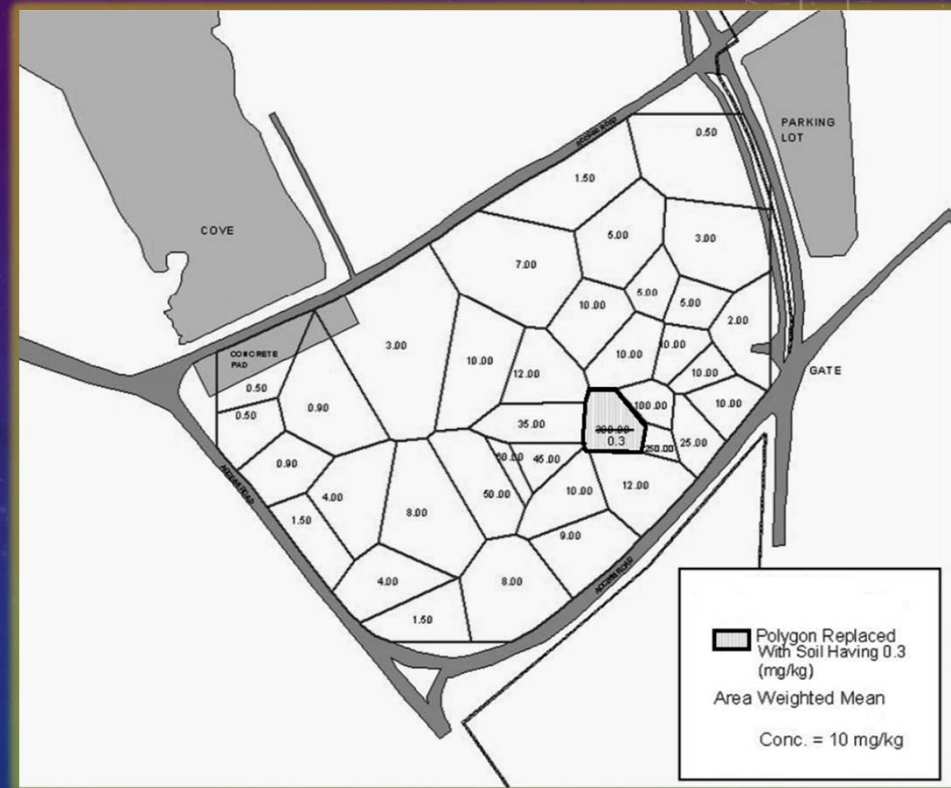
SPATIALLY WEIGHTED AVERAGING - EXAMPLE

- Generate Thiessen Polygons
- Sample result assigned to each polygon
- Area Weighted Mean is calculated to determine whether standard is attained.



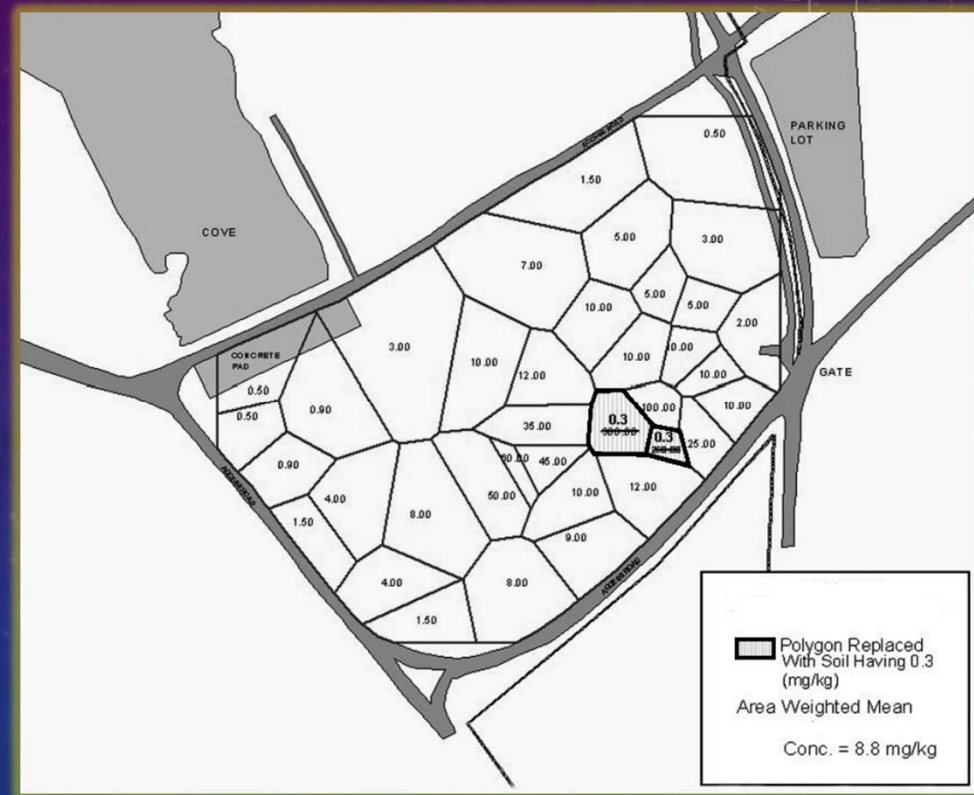
SPATIALLY WEIGHTED AVERAGING - EXAMPLE

- Polygon with highest COC concentration is replaced (“remediated”) with fill COC concentrations
- Area Weighted Mean is re-calculated to determine whether standard is attained



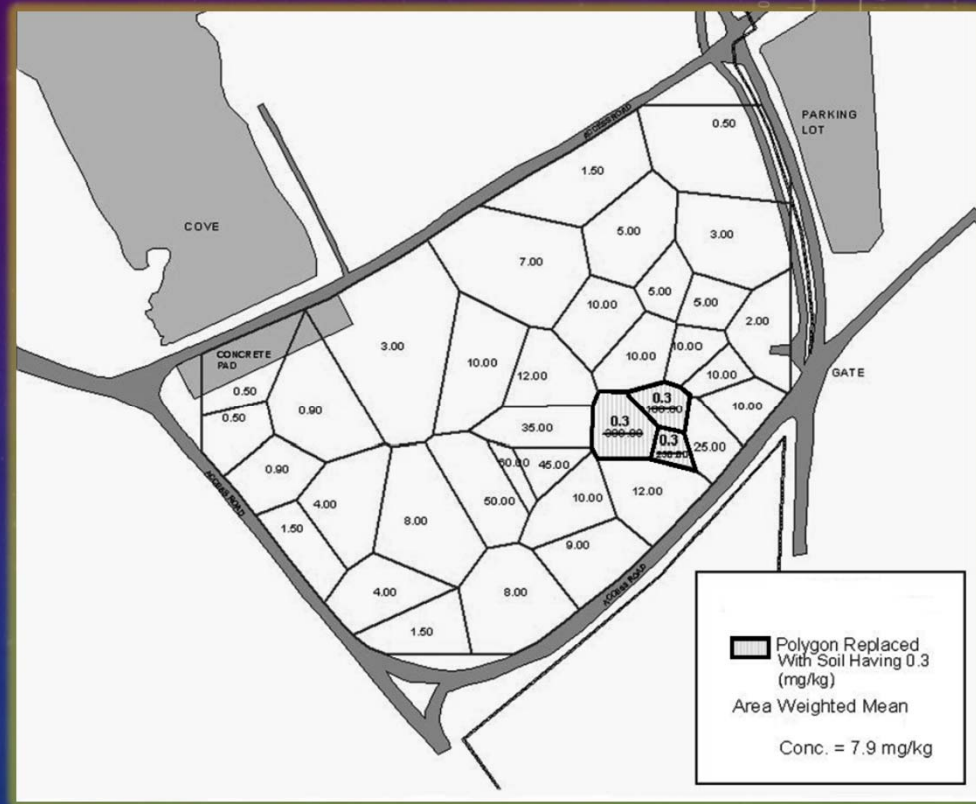
SPATIALLY WEIGHTED AVERAGING - EXAMPLE

- Process is continued iteratively with next highest COC concentration, until Area Weighted Mean \leq applicable standard.
- Must be completed for each COC, for each pathway, and for both surface and subsurface soil



SPATIALLY WEIGHTED AVERAGING

- Once Area Weighted Mean is \leq applicable standard, only those polygons replaced require remediation.
- Remediation does not necessarily mean removal, Engineering controls can be utilized.



75 PERCENT/10X PROCEDURE

- Borrowed from PADEP Technical Guidance Manual for Act II
- Compliance averaging using 75/10x can only be conducted after RA has been completed.
- Minimum of eight (8) post remedial soil samples are required per AOC to utilize this option
- Minimum number of samples scaled to volume of soil excavated:
 - 8 samples for up to 125 cy
 - 12 samples for up to 3,000 cy
 - 12 additional samples for each additional soil volume of 3,000 cy
- All samples utilized for 75%/10X must be collected within the zone of COC impacts. If COCs were limited to depths ranging from 2 - 4 feet and overlying soils were not impacted, all samples for 75%/10X must be collected from the 2 - 4 foot depth interval.
- If 75 percent of all post-remedial samples are below the applicable remediation standard and none of the remaining samples exceed the applicable standard by an order of magnitude, the RA is considered complete.