Water Quality Assessment/Policy 1-11 Updates
Human Health Criteria Alternatives Proposed by Ecology
March 2017

(This does not address methylmercury, copper and asbestos HHC)

Ecology has considered the various aspects of using human health criteria (HHC) and related lines of evidence to assess waterbodies for the protection of human health. Taking into consideration the public dialogue and researching the potential for using different lines of evidence, Ecology is proposing its alternatives for assessing waters for human health protection.

1. Background

- Human health criteria (HHC) are intended to provide a high level of protection for people who use a waterbody as a domestic water supply and/or to harvest fish and shellfish for consumption.
- Using water column data to determine that a waterbody is impaired for HHC is challenging for various reasons, including the difficulty in measuring toxic pollutants at low enough levels to determine compliance (many HHC concentrations are below the levels that laboratory methods can detect). Another is difficulty is determining the persistence of a pollutant concentration through periodic water samples (many criteria are developed assuming a duration of exposure).
- Because of the challenges with analyzing HHC in the water column, in previous Water Quality Assessments Ecology made listing decisions based on the use of Fish Tissue Equivalent Concentrations (FTECs), which were levels derived from applying bio-concentration factors to calculate a maximum allowable tissue concentration given an

assumed average water column concentration equivalent to the HHC. Thus, we inferred that these tissue values were representative of the average allowable concentration in the water column.

- The term "chemical" is used loosely and interchangeably with the term "parameter" in this proposed assessment method. For example, a number of chemicals are included under the single parameter "polychlorinated biphenyls (PCBs)", so when we are referring to the chemical "PCBs" in this document, we are actually referring to an entire group of chemicals that fall under this parameter name.
- For this proposal, we would continue to use fish tissue as a pathway to assess the protection of human health by analyzing chemical levels found in tissue. However, we are proposing to use a simpler Tissue Exposure Concentration (TEC) to represent a more direct measure of maximum allowable tissue exposure to these chemicals. FTECs used in previous listing cycles were derived using bio-concentration factors, which can vary waterbody by waterbody and are not consistently used in the currently approved HHC. Therefore, focusing on the fish tissue exposure more directly addresses the beneficial use of harvest, one of the uses that the HHC are intended to protect.
- Likewise, we would also look at the direct exposure of the chemical on ingesting untreated water by using relevant parts of the HHC equation to derive a Drinking Water Exposure Concentration (DWEC). More details are provided below on both the TEC and DWEC.
- Where the assessment methodology using TEC and DWEC are insufficient, other lines of evidence may also be considered to place waters into the various Assessment categories, such as fish advisories or maximum contaminant levels (MCLs) using for drinking water.

Lines of Evidence

Ecology considered using the numeric HHC as a direct line of evidence for Category 5 listings and has concluded that there are numerous discrepancies and challenges with using numeric HHC alone as a basis for determining impairment. One key challenge is that many of the toxic pollutants aren't measurable at low enough levels because the HHC concentrations are below detection and quantification limits. In addition, because the criteria are developed based on a lifetime of exposure, determining the duration and volume of data needed to determine persistent impairment is also challenging. Ecology notes that the exception to this is the new HHC for methylmercury, since these are already expressed as tissue concentrations.

Given the challenges with using numeric HHC alone to determine impairment, Ecology is proposing lines of evidence that are more directly related to the beneficial uses that the numeric HHC are intended to protect, and that could be used to assess both harvesting and drinking water exposures based on relevant parts of the HHC equation:

- Determining a Tissue Exposure Concentration (TEC)—Alternatives described below.
- Determining a Drinking Exposure Concentration (DWEC)—Alternatives described below.

Attachment 1 provides a Chemical Comparison Table that provides threshold levels for tissue exposure concentrations (TEC) and drinking water exposure concentrations (DWEC) that are being proposed to assess the health of the designated uses of harvest and domestic water

supply. If a field in the table is blank, it means that there is no carcinogen or non-carcinogen level assigned to that chemical.

Ecology would consider using HHC alone as a direct line of evidence for category listings and de-listings but would need to work with the data submitter to develop a statistically valid study that would validate the persistence of HHC being met, or not met, within a waterbody.

Ecology also considered other lines of evidence that are intended to assess the status of the designated uses individually, apart from the numeric HHC, and could be used in addition to the above lines of evidence related to the HHC:

- Department of Health (DOH) Fish Advisories: DOH Fish Advisories represent a direct relation to an impaired use of harvest. Therefore, waterbody segments with data associated with the Fish Advisory may be used in the Assessment process as a multiple line of evidence if they aren't already captured in the pathway described above using the TEC. Ecology's use of the TEC would always be lower than current numeric basis for considering a fish advisory, because we apply a greater fish consumption rate (175 g/day). Therefore, we anticipate that listings based on a TEC would already encompass fish advisories done for priority pollutants. Nonetheless, there may be examples of where a DOH fish advisory could be used as another line of evidence.

- Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCL): SDWA MCLs represent a direct relation to protection of drinking water sources. However, MCLs are intended to be applied as a limit at water treatment facilities after the water has been treated for drinking. There are also several assumption made about how MCLs are derived that do not easily fit within the framework of the Assessment. Nonetheless, there may be examples of where a drinking water MCL could be used in the Assessment process as a multiple line of evidence if they aren't already captured in the pathway using the DWEC.

Weight of evidence

During the December 14, 2016 public dialogue on the use of fish tissue, participants were supportive of using multiple lines of evidence and weight of evidence concepts to validate impairment, but also emphasized the need to have this done in a methodical fashion so that it could be reproducible.

A weight of evidence approach is built into the proposed drinking water and harvest use assessments in that the magnitude of exceedances, number of available samples, and indications of persistence of a chemical are considered in the data evaluation. For example, when a chemical in samples of fish tissue level exceed the upper threshold (i.e. the TEC), the magnitude of the concentration has more weight in the analysis and therefore, less data is needed to support a Category 5 determination. Ecology does not think it is necessary to require multiple lines of evidence for every listing. Such rigidity would inflate the risk of Type II errors (concluding there's not a problem when there really is) and would preclude valid impairment

determinations just because additional lines of evidence are either not available or are inconclusive. Instead, multiple lines of evidence are incorporated into the analysis when the weight of the primary data type is insufficient by itself to support a listing determination.

In rare situations the assessment method alone may be insufficient to determine the proper category for a waterbody. This is because the pathways in this proposal cannot be constructed to address every possible situation we may encounter. For example, for a given chemical there may be only a single composite sample result available for each of several different fish species, all of which exceed the TEC by a large margin, and there may be accompanying water samples that show high levels of the chemical in the water. This type of situation indicates impairment of the harvest use, but would be placed in Category 3 under the pathways described in this document. In situations like this, staff from Ecology's Water Quality and the Environmental Assessment Programs would confer to make a category assignment decision based on the available multiple lines of evidence and the weight of evidence. A weight of evidence approach might also be used in instances where additional information would validate that a toxin found in fish tissue was not coming from sources directly affecting a waterbody. These situation specific determinations will be clearly documented in the listing's assessment record and as with all listings, the public will have an opportunity to review and comment on them prior to their submittal to EPA. This type of approach would be similar to that described in The State of California's *Water Quality Control Policy For Developing California's Clean Water Act Section 303(d) List.*

(http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2015/020315_8_amendment_clean_version.pdf)

2. Alternatives for Evaluating for Fish and Shellfish Harvest Use Support

Ecology is considering the assessment of harvesting use by using a simplified equation to determine the tissue exposure concentrations (TEC) of pollutants that would correspond to the criteria equations, but with a tissue-only exposure pathway. Simply put, the TEC calculates the tissue exposure using the following assumptions that were used in the human health criteria (for example, fish consumption rate of 175 g/day, risk level of 10^{-6}, body weight of 80 kilograms, and toxicity factors used by EPA in its criteria documents). The derivation of the TEC varies between carcinogenic and non-carcinogenic effects because of the assumptions that need to be accounted for in the duration of exposure for carcinogens.

#1. For chemicals that have a non-carcinogenic effects level (TEC^N):
(Reference dose) x (Body weight) ÷ Fish consumption rate = **TEC^N**

#2. For chemicals that have a carcinogenic effect level (TEC^C):
(Risk level) x (Body weight) ÷ (Cancer slope factor) x (Fish consumption rate) = **TEC^C**

The pathway to Category 5 for non-carcinogens is through comparison against the TEC^N. There are one or two pathways to Category 5 for carcinogens, depending on what the chemical is. The pathway to Category 5 for carcinogens that only have a cancer effect level is through comparison against the TEC^C. Many carcinogens also have non-cancer health effects above certain concentrations. We would assess a chemical that has both non-carcinogenic and carcinogenic health endpoints through separate comparisons against its non-carcinogen tissue exposure concentration (TEC^N) threshold and its carcinogen threshold (TEC^C). A listing for such a carcinogen may therefore qualify for Category 5 through the TEC^N Category 5 pathway and/or the TEC^C Category 5 pathway. The number of chemicals in each of these three groups that are addressed by this proposed assessment method are listed below:

- Non-carcinogens (have only a TEC^N): 45 parameter
- Carcinogens with only a cancer effect threshold (have only a TEC^C): 15 parameters
- Carcinogens with cancer and non-cancer effect thresholds (have both a TEC^N and a TEC^C): 36 parameters

Data Representativeness for Tissue Samples

The following factors are used to determine what tissue data will be used for assessment purposes, unless otherwise specified in the individual alternative descriptions:

- **Tissue characteristics:** Fin fish fillet tissue samples, whole shellfish tissue samples, and edible shellfish muscle samples are used to create a composite sample made up of at least three individual fish. All fish in the composites must be of the same species. The fish used in each composite should be of similar size (i.e. total length of smallest being no less than 75% the total length of the largest). Only individuals of a single species can constitute an individual composite sample. Each composite sample is compared against the TEC. All samples are treated as independent whether or not they were collected in the same day, season, or year.

    - *Combining Individual fish into a quasi-composite sample value:* This applies when separate sampling events in a year each collected a fish from a certain species, but no one event collected enough individuals to make a composite sample for that event. Three or more individual fish from the same year will be combined to make one quasi-composite sample. The median value of the chemical among the individual fish used is assigned as the quasi-composite sample value.
- **Site fidelity:** Freshwater tissue samples must be from species that are in their primary waterbody of residence (e.g. cannot use lake dwelling trout that are caught in stream spawning habitat and list the stream, but can use river dwelling fish that migrate seasonally within the same river- the listed segment for the latter is the catch site). Marine tissue samples must be from species with high site fidelity (for example, cannot use salmon, herring, etc. to list a marine grid cell in Cat 5).
- **Species Used:** Edible species should be used. If fishing regulations prohibit harvest of a species, then it is excluded. This will be defined in a general species list and not a waterbody specific, or season specific list.
- **Age of Fish:** Age of fish will be considered when there are multiple species and information on the age of fish is available, with the goal of representing current conditions.
- **Trophic level:** Irrelevant for listing to Category 5, but upper trophic levels of edible species needed for de-listing to Category 1 (Exception: shellfish can be used to list and delist for polycyclic aromatic hydrocarbons (PAHs) because they are a better indicator of contamination).
- **Segments represented by Tissue Data:** If fish are collected from more than one segment (assessment unit in NHD) to constitute a composite sample, then the resulting listings applies to all associated segments.
- **Data evaluation:** We cannot accurately estimate the mean and standard deviation for small datasets that tend to have many non-detects, so we cannot construct a confidence interval, but we can reliably determine if the median is above a given threshold using a binning approach. Using a binning approach, we can assess if sample values exceed the applicable threshold (TEC^N and/or TEC^C) even if method detection limits (MDLs) and practical quantitation limits (PQLs) vary among samples in a dataset and/or when the TEC^N or TEC^C is below a PQL or MDL. This allows us to use data points that are non-detects or are between

the MDL and PQL. Although this approach is not perfect, it represents a balance between using complicated statistical analysis for each waterbody or alternatively, substituting inaccurate values for non-detects, both of which have substantial drawbacks.

The following describes the binning approach that would be applied:

- Each sample is independently compared against the applicable threshold (TEC^N and/or TEC^C). A sampled is assigned a "1" if it exceeds the threshold and a "0" if it does not.
- If the threshold is below the MDL, then a sample is assigned a "1" if it is above the MDL. If the threshold is between the MDL and PQL, then a sample is assigned a "1" if it is above the PQL. If the threshold is above the PQL, then a sample is assigned a "1" if it is above the threshold and a "0" if it is below the threshold, or below the PQL.
- **Determining if a median exceeds a threshold:** After each composite sample for a given species is assigned a number, then the median of the composites for a given species is evaluated. If the median for the set of composites for any given species is "1", then the dataset qualifies for Category 5. Using this method makes it irrelevant that different samples may have different MDLs and/or PQLs and eliminates bias in the numeric value of the median caused by outlier values in a composite sample.

Fish and Shellfish Harvest Use Category Determinations

Category determinations Categories 5, 2, and 1 are broken out for non-carcinogens and carcinogens and described in the following pages. A "Quick View" Categories Table for Fish and Shellfish Harvest can be found in Attachment 2.

Fish and Shellfish Harvest Use Category Determinations for Non-carcinogens

- **Category 5-Pathway 1**
  - The median composite sample value for any single species exceeds the TEC^N**.** A minimum of two composite samples from a single species is required, although three or more are preferred. If there are only two composite samples and both samples exceed the TEC^N, the listing will be placed in category 5 because the median is above the TEC^N and it is not possible for the collection of a third sample to shift the median value below the TEC^N.
  - The samples may come from the same or separate years. The median for each sampled species is separately compared against the TEC^N. If the number of composite sample is an even number then the majority of the composite samples must be above the TEC^N.
  - Only uses species that have high site fidelity.
  - *Justification:* Independent evidence. This method intends to evaluate the typical level of a toxin in fish. If 2 of 3 samples exceed, then the median and average also exceed. It is not likely that we can accurately calculate mean and standard deviation with data that tends to have many non-detects, so we cannot reliably perform statistical analyses on the data, but we can reliably determine if a TEC^N value is in a given "bin", e.g. above or below the MDL or PQL.

- **Category 2-Pathway 1**
  - Any 1 composite sample exceeds the TEC^N.
  - Additional sample characteristics: Only 1 composite sample needed.
  - Site Fidelity: Applies to all species, but species that are caught in migration or have low site fidelity (e.g. salmon & steelhead) are placed in Category 2.
  - If for some reason a listing qualifies for Category 2 and 1 concurrently, then default to Category 1. If qualifies for Cat 5 and 2 concurrently, then default to Category 5.
  - *Justification:* not enough samples to verify exceedance of the threshold.

- **Category 1 Pathway 1**
  - Median of composite samples does not exceed the TEC^N.
  - Requires a minimum of 2 or more composite samples.
  - Requires a minimum 2 or more non-exceedances of the TEC^N.
  - Only uses species that have high site fidelity.
  - Trophic level: upper trophic level of edible species needed (Exception: shellfish can be used to list and delist for polycyclic aromatic hydrocarbons (PAHs) because they are a better indicator of contamination).
  - *Justification:* Typical levels of the non-carcinogen are below the non-cancer effects threshold.

- **Category 3**
    - If the data does not qualify for any other category, it will either be placed in Category 3, or it may be placed in Cat 1, 2, or 5 based on an individualized review of the available data.
    - *Justification:* There may be unique situations in which a dataset indicates impairment or non-impairment but does not qualify for Category 1, 2, or 5. It may be appropriate to place a such in a category other than Category 3. Example: multiple individual fish of different species or age classes have been collected but cannot be used to constitute a composite sample, the presence of a toxin in tissue is verified, and the toxin is measurable in the water or sediment- we may want to designate this as Category 2.

See Attachment 2 for a Quick View Table of Fish and Shellfish Harvesting Alternatives.

Fish and Shellfish Harvest Use Category Determinations for Carcinogens

- **Category 5-Pathway 1**
    - This pathway applies only to the 36 carcinogens that also have non-cancer effects and therefore have an associated TEC^N; these chemicals are also eligible for Category 5-pathway 2.
    - The median composite sample value for any single species exceeds the TEC^N**.** A minimum of two composite samples from a single species is required, although three or more are preferred. A minimum of 2 exceedances for a single species is required: if there are only two composite samples and both samples exceed the TEC^N, the listing will be placed in category 5 because the median is above the TEC^N and it is not possible for the collection of a third sample to shift the median value below the TEC^N.
    - The samples may come from the same or separate years. The median for each sampled species is separately compared against the TEC^N. If the number of composite sample is an even number then the majority of the composite samples must be above the TEC^N.
    - Only uses species that have high site fidelity.
    - *Justification:* Independent evidence. This method intends to evaluate the typical level of a toxin in fish. If 2 of 3 samples exceed, then the median and average also exceed. It is not likely that we can accurately calculate mean and standard deviation with data that tends to have many non-detects, so we cannot reliably perform statistical analyses on the data, but we can reliably determine if a TEC^N value is in a given "bin", e.g. above or below the MDL or PQL.

- **Category 5-Pathway 2**
  - This pathway applies to all carcinogens.
  - The median composite sample value for any single species exceeds the cancer TEC^C AND the parameter exceeds the $DWEC^C$ in >10% of water samples or exceeds a sediment quality standard (SQS) in one or more sediment samples.
  - A minimum of three composite samples from a single species is required, although five or more are preferred. A minimum of 3 exceedances for a single species is required: if there are only three composite samples and all three samples exceed the TEC^C, the listing will be placed in Category 5 because it is not possible for the collection of a fourth or fifth sample to shift the median value below the TEC^C.
  - The samples must come from 2 or more years and the time span between the first exceedance used and the last exceedance used (within the 10 year data window) must be 48 months or more.
  - The median for each sampled species is independently compared against the TEC^C. If the number of composite sample is an even number then the majority of the composite samples must be above the TEC^C.
  - *Additional evidence:* Water/sediment data from the 10 year data window is reviewed; the date of the water/sediment data does not matter, e.g. if before or after the tissue samples. We are not assessing if there is a problem with the water or sediment in this pathway, we are only assessing if there is an apparent linkage between the chemical in tissue, water and/or sediment.
  - *Justification:* Listing for cancer effects would be based on a weight of evidence. For purposes of listing, we are determining that a 4 year separation between exceedances indicates long term persistence. When the median value is above the applicable threshold, then we can assume with a reasonable level of confidence that the chemical is typically above the cancer effects level in the fish. A tissue level above the cancer effects threshold and elevated levels of the chemical in one or more water or sediment samples establishes a linkage between water quality in the waterbody and impairment of the harvest use.

- **Category 2-Pathway 1**
  - This pathway applies only to the 36 carcinogens that also have non-cancer effects and therefore have a TEC^N; these chemicals are also eligible for Category 2- pathway 2.
  - Any 1 composite sample exceeds the TEC^N.
  - Additional sample characteristics: only 1 composite sample needed.
  - Site Fidelity: Applies to all species, but species that are caught in migration or have low site fidelity (e.g. salmon & steelhead) are placed in a subcategory of Category 2, e.g. 2H.

- Category 2 has some overlap with Categories 5 and 1. If a listing qualifies for Categories 5 and 2 concurrently, then default to Category 5; if it qualifies for Category 2 and 1 concurrently, then default to Category 1.
- *Justification:* generally indicates there are not enough samples to verify exceedance of the threshold.

- **Category 2-Pathway 2**
  - This pathway applies to all carcinogens.
  - 2 composite samples exceed the TEC^C.
  - Site Fidelity: Applies to all species, but species that are caught in migration or have low site fidelity (e.g. salmon & steelhead) are placed in Category 2.
  - If a listing qualifies for Categories 2 and 1 concurrently, then default to Category 1. If it qualifies for Category 5 and 2 concurrently, then default to Category 5.
  - *Justification:* not enough samples to verify exceedance of the threshold.

- **Category 1-Pathway 1**
  - Median of composite samples does not exceed the TEC^C.
  - Sample Characteristics: Requires 3 or more composite samples.
  - Requires 3 a minimum of 3or more non-exceedances of the TEC^C.
  - Site Fidelity: Only uses species that have high site fidelity.
  - Trophic level: upper trophic level of edible species needed (Exception: shellfish can be used to list and delist for polycyclic aromatic hydrocarbons (PAHs) because they are a better indicator of contamination).
  - *Justification:* Typical levels of the carcinogen are below the cancer effects threshold.

- **Category 3**
  - If the data does not qualify for any other category, it will either be placed in Category 3, or it may be placed in Category 1, 2, or 5 based on an individualized review of the available data.
  - *Justification:* There may be unique situations in which a dataset indicates potential problems, but does not qualify for Category 1, 2, or 5. We may want to place these in one of these categories instead of Category 3. Example: multiple individual fish of different species or age classes have been collected but cannot be used to constitute a composite sample, the presence of a toxin in tissue is verified, and the toxin is measurable in the water or sediment- we may want to designate this as Category 2.

See Attachment 2 for a Quick View Table of Fish and Shellfish Harvesting Alternatives.

3. Alternatives for Evaluating for Domestic Water Supply

Ecology is considering the assessment of drinking water use associated with the HHC by using a simplified equation to determine the Drinking Water Exposure Concentration (DWEC) of pollutants that would correspond to the criteria equations, but with a drinking water-only exposure pathway (tissue exposure removed). Simply put, the DWEC calculates the drinking water exposure using the following assumptions that were used to develop the human health criteria (2.4L/day water ingestion, risk level of 10^{-6}, body weight of 80 kilograms, and toxicity factors used by EPA in its criteria documents). The derivation of the DWEC varies between carcinogenic and non-carcinogenic effects because of the assumptions that need to be accounted for in the duration of exposure for carcinogens.

#1. For chemicals that have a non-carcinogenic effects level ($DWEC^N$):
(Reference dose) x (Body weight) ÷ Drinking water rate = $DWEC^N$

#2. For chemicals that have a carcinogenic effect levels ($DWEC^C$):
(Risk level) x (Body weight) ÷ (Cancer slope factor) x (Drinking water rate) = $DWEC^C$

The pathway to Category 5 for non-carcinogens is through comparison against the $DWEC^N$. There are one or two pathways to Category 5 for carcinogens, depending on what the chemical is. The pathway to Category 5 for carcinogens that only have a cancer effect level is through comparison against the $DWEC^C$. Many carcinogens also have non-cancer health effects above certain concentrations. We would assess a chemical that has both non-carcinogenic and carcinogenic health endpoints through separate comparisons against its non-carcinogen tissue exposure concentration ($DWEC^N$) threshold and its carcinogen threshold ($DWEC^C$). A listing for such a carcinogen may therefore qualify for Category 5 through the $DWEC^N$ Category 5 pathway and/or the $DWEC^C$ Category 5 pathway. The number of chemicals in each of these three groups that are addressed by this proposed assessment method are listed below:

- Non-carcinogens (have only a $DWEC^N$): 45 parameter
- Carcinogens with only a cancer effect threshold (have only a $DWEC^C$): 15 parameters
- Carcinogens with cancer and non-cancer effect thresholds (have both a $DWEC^N$ and a $DWEC^C$): 36 parameters

Data Representativeness for water column samples

The following factors are used to determine what water column data will be used for assessment purposes**:**

- **Sampling methods:** Data from "grab samples" will be the primary means for assessing the domestic water supply use. Data from standardized "pre-concentration" sampling methods (e.g. high volume water samplers) may be considered in the evaluation.
- **Sample independence:** Samples collected at least 24 hours apart are treated as independent.
- **Notes on data evaluation:** We cannot accurately estimate the mean and standard deviation for small datasets data that tend to have many non-detects, so we cannot practically construct a confidence interval, but we can reliably determine if the median is above a given threshold using a binning approach. Using a binning approach, we can assess if sample values exceed a threshold ($DWEC^N$ or $DWEC^C$) even if method detection limits (MDLs) and practical quantitation limits (PQLs) vary among samples in a dataset and/or when the $DWEC^N$ or $DWEC^C$ is below a PQL or MDL. This allows us to use data points that are non-detects or are between the MDL and PQL. Although this approach is not perfect, it represents a balance between using complicated statistical analysis for each waterbody or alternatively, substituting inaccurate values for non-detects, both of which have substantial drawbacks.

  The following describes the binning approach that would be applied:
  - Each sample is independently compared against the applicable threshold. A sampled is assigned a "1" if it exceeds the threshold and a "0" if it does not.
  - If the threshold is below the MDL, then a sample is assigned a "1" if it is above the MDL. If the threshold is between the MDL and PQL, then a sample is assigned a "1" if it is above the PQL. If the threshold is above the PQL, then a sample is assigned a "1" if it is above the threshold and a "0" if it is below the threshold, or below the PQL.
  - **Determining if a median exceeds a threshold:** after each composite sample for a given species is assigned a number, then the median of the composites for a given species is evaluated. If the median for the set of composites for any given species is "1", then the dataset qualifies for Category 5. Using this method makes it irrelevant that different samples may have different MDLs and/or PQLs and eliminates bias in the numeric value of the median caused by outlier values in a composite sample.

Domestic Water Supply Use Category Determinations

Category determinations Categories 5, 2, and 1 are broken out for non-carcinogens and carcinogens and described in the following pages. A "Quick View" Categories Table for Domestic Water Supply can be found in Attachment 3.

Domestic Water Supply Category Determinations for Non-carcinogens

- **Category 5-Pathway 1**
  - Greater than 10% of sample values exceed the $DWEC^N$; there must be a minimum of two exceedances.
  - Based on 2 or more samples collected in the ten year assessment window. The time span between the first and last exceedance must be more than 12 or more months apart.
  - Can subsequently de-list to Cat 1, 2, or 3.
  - *Justification:* The $DWEC^N$ is used here in a manner similar to an acute aquatic life criterion. With typical data sets of less than 20 samples, 2 exceedances exceed the 10% decision rule. The 12 month minimum temporal span is intended to address persistence.

- **Category 2-Pathway 1:**
  - Any single value exceeds the $DWEC^N$.
  - No minimum sample size,
  - No timespan requirements.
  - J*ustification:* We don't know the true frequency and duration of exceedances, but if a random sample in a very limited dataset exceeds the non-cancer $DWEC^N$, it indicates that harm to the drinking water use could be occurring.

- **Category 1-Pathway 1:**
  - ≥90% of sample values do not exceed the $DWEC^N$.
  - Based on 25 or more samples from at least 3 separate years in a ten year period.
  - *Justification:* If 90% or more of the samples do not exceed the $DWEC^N$, then we can be reasonably confident that the health risk associated with the parameter is probably not elevated assuming that concentrations stay at the observed level over the course of a person's lifetime.

See Attachment 3 for a Quick View Table of Domestic Water Supply Alternatives.

Domestic Water Supply Category Determinations for Carcinogens

- **Category 5-Pathway 1**
  - This pathway applies only to the 36 carcinogens that have non-cancer effects and therefore have a $DWEC^N$; these chemicals are also eligible for Category 5- pathway 2.
  - More than 10% of sample values exceed the $DWEC^N$; there must be a minimum of two exceedances.
  - Based on 2 or more samples collected in the ten year assessment window. The time span between the first and last exceedance must be more than 12 or more months apart.
  - Can subsequently de-list to Cat 1, 2, or 3 if % of samples exceeding drops to 10% or less.
  - *Justification:* The $DWEC^N$ is used here in a manner similar to an acute aquatic life criterion. With typical data sets of less than 20 samples, 2 exceedances exceed the 10% decision rule. The 12 month minimum temporal span is intended to address persistence.

- **Category 5-Pathway 2**
  - This pathway applies to all carcinogens.
  - The median sample concentration (i.e. ≥50% of sample values) is above the $DWEC^C$ AND the parameter has been detected in one or more fish/shellfish composite tissue samples.
  - Based on 5 or more samples. The time span between first and last exceedance must be more than 24 month
  - Can subsequently de-list to Cat 1, 2, or 3, e.g. if further sampling results in the median value dropping below the $DWEC^C$.
  - *Justification***:** The $DWEC^C$ is analogous to a chronic aquatic life criterion. When the median value is above the applicable threshold, we can be reasonably confident that the chemical is typically above the cancer effects level in the waterbody. Five samples are required in order to align with the other Category 5 pathway, otherwise it would be just as easy to get into Category 5 using the more stringent $DWEC^C$ as it would with the $DWEC^N$.

- **Category 2-Pathway 1**
  - This pathway applies only to the 36 parameters that have a $DWEC^N$; these chemicals are also eligible for Category 2- pathway 2.
  - Any single value exceeds the $DWEC^N$.
  - No minimum sample size, no timespan requirements.
  - *Justification:* We don't know the true frequency and duration of exceedances, but if a random sample in a very limited dataset exceeds the non-cancer $DWEC^N$, it indicates that harm to the drinking water use could be occurring.

- **Category 2-Pathway 2**
  - Greater than 10% of samples exceed the $DWEC^C$.
  - There must be a minimum of two exceedances.
  - No timespan requirements.
  - *Justification:* We don't know the true frequency and duration of exceedances, but if a random sample in a very limited dataset exceeds the non-cancer $DWEC^C$, it indicates that harm to the drinking water use could be occurring.

- **Category 1:**
  - ≥90% of samples are below the $DWEC^C$.
  - Based on 25 or more samples from at least 3 separate years in a ten year period.
  - *Justification:* If 90% or more of the samples are below $DWEC^C$, then we can be reasonably confident that the health risk associated with the parameter is probably not elevated assuming that concentrations stay at the observed level over the course of a person's lifetime.

- **Category 3**
  - If data does not qualify for any other category, it will either be placed in Category 3, or Cat 1, 2, or 5 based on an individualized review of the dataset.
  - *Justification:* There may be unique situations in which a dataset has or does not have exceedances, but does not qualify for Category 1, 2, or 5. We may place these in one of those categories instead of Category 3 on a case by case basis.

See Attachment 3 for a Quick View Table of Domestic Water Supply Alternatives.

ATTACHMENT 1: DRAFT Chemical Comparison Table of Tissue Exposure Concentrations and Drinking Water Exposure Concentration with Human Health criteria covered by this paper.

TECs and DECs largely based on WA criteria inputs (10^{-6} risk level, hazard quotient = 1, 80 kg. body weight, 2.4 L/day water ingestion, 175 g/day tissue ingestion, CSFs and RfDs in the EPA criteria documents are used in most cases).
CWA-approved criteria in WAC 173-201A-240
CWA criteria in 40 CFR 131.45

40 CFR 131.45 Chemical #	Chemical Name	CAS # - 1	Tissue Exposure Concentration (TEC)		Drinking Water Exposure Concentration (DWEC)		Numeric surface water criteria for use in CWA programs	
			TEC^C (Cancer) (ppm) (mg/kg)	TEC^N (Non-cancer) (ppm) (mg/kg))	$DWEC^C$ (Cancer) (ppb) (µg/L)	$DWEC^N$ (Non-cancer) (ppb) (µg/L)	Criterion - Water & Organisms (ppb) (µg/L)	Criterion - Organisms Only (ppb) (µg/L)
1	1,1,1-Trichloroethane	71556	-	910	-	67000	20000	50000
2	1,1,2,2-Tetrachloroethane	79345	0.0023	9.1	0.17	670	0.1	0.3
3	1,1,2-Trichloroethane	79005	0.0080	1.8	0.58	130	0.35	0.9
4	1,1-Dichloroethylene	75354	-	23	-	1700	700	4000
5	1,2,4-Trichlorobenzene	120821	0.016	4.6	1.1	330	0.036	0.037
6	1,2-Dichlorobenzene	95501	-	140	-	10000	700	800
7	1,2-Dichloroethane	107062	0.14	36	10	2600	8.9	73
8	1,2-Dichloropropane	78875	0.013	41	0.93	3000	0.71	3.1
9	1,2-Diphenylhydrazine	122667	0.00057	-	0.042	-	0.01	0.02
10	1,2-Trans-Dichloroethylene	156605	-	9.1	-	670	200	1000

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			TEC^C (Cancer) (ppm) (mg/kg)	TEC^N (Non-cancer) (ppm) (mg/kg))	$DWEC^C$ (Cancer) (ppb) (µg/L)	$DWEC^N$ (Non-cancer) (ppb) (µg/L)	Criterion - Water & Organisms (ppb) (µg/L)	Criterion - Organisms Only (ppb) (µg/L)
11	1,3-Dichlorobenzene	541731	-	0.91	-	67	2	2
12	1,3-Dichloropropene	542756	0.0037	11	0.27	830	0.22	1.2
13	1,4-Dichlorobenzene	106467	-	32	-	2300	200	200
14	2,3,7,8-TCDD (Dioxin)	1746016	-	0.00000032	-	0.000023	0.000000013	0.000000014
15	2,4,6-Trichlorophenol	88062	0.042	0.46	3.03	33	0.25	0.28
16	2,4-Dichlorophenol	120832	-	1.4	-	100	10	10
17	2,4-Dimethylphenol	105679	-	9.1	-	670	85	97
18	2,4-Dinitrophenol	51285	-	0.91	-	67	30	100
19	2,4-Dinitrotoluene	121142	0.00069	0.91	0.050	67	0.039	0.18
20	2-Chloronaphthalene	91587	-	37	-	2700	100	100
21	2-Chlorophenol	95578	-	2.3	-	170	15	17
22	2-Methyl-4,6-Dinitrophenol	534521	-	0.14	-	10	3	7
23	3,3'-Dichlorobenzidine	91941	0.0010	-	0.074	-	0.0031	0.0033
24	3-Methyl-4-Chlorophenol	59507	-	46	-	3300	36	36
25	4,4'-DDD	72548	0.0019	0.23	0.14	17	0.0000079	0.0000079
26	4,4'-DDE	72559	0.0027	0.23	0.20	17	0.00000088	0.00000088
27	4,4'-DDT	50293	0.0013	0.23	0.098	17	0.0000012	0.0000012

40 CFR 131.45 Chemical #	Chemical Name	CAS # - 1	Tissue Exposure Concentration (TEC)		Drinking Water Exposure Concentration (DWEC)		Numeric surface water criteria for use in CWA programs	
			TEC^C (Cancer) (ppm) (mg/kg)	TEC^N (Non-cancer) (ppm) (mg/kg))	$DWEC^C$ (Cancer) (ppb) (µg/L)	$DWEC^N$ (Non-cancer) (ppb) (µg/L)	Criterion - Water & Organisms (ppb) (µg/L)	Criterion - Organisms Only (ppb) (µg/L)
28	Acenaphthene	83329	-	27	-	2000	30	30
29	Acrolein	107028	-	0.23	-	17	1	1.1
30	Acrylonitrile	107131	0.00085	-	0.062	-	0.019	0.028
31	Aldrin	309002	0.000027	0.014	0.0020	1.0	0.000000041	0.000000041
32	alpha-BHC	319846	0.000073	3.7	0.0053	270	0.000048	0.000048
33	alpha-Endosulfan	959988	-	2.7	-	200	6	7
34	Anthracene	120127	-	140	-	10000	100	100
35	Antimony	7440360	-	0.18	-	13	6	90
36	Arsenic	7440382	-	0.14	-	10	0.018	0.14
37	Asbestos (not addressed in this paper)	1332214	-	-	-	-	7,000,000 (fibers/L)	-
38	Benzene	71432	0.0083	0.23	0.61	17	0.44	1.6
39	Benzidine	92875	0.0000020	1.4	0.00014	100	0.00002	0.000023
40	Benzo(a)Anthracene	56553	0.00063	-	0.046	-	0.00016	0.00016
41	Benzo(a)Pyrene	50328	0.000063	-	0.0046	-	0.000016	0.000016
42	Benzo(b)Fluoranthene	205992	0.00063	-	0.046	-	0.00016	0.00016
43	Benzo(k)Fluoranthene	207089	0.0063	-	0.46	-	0.0016	0.0016

40 CFR 131.45 Chemical #	Chemical Name	CAS # - 1	Tissue Exposure Concentration (TEC)		Drinking Water Exposure Concentration (DWEC)		Numeric surface water criteria for use in CWA programs	
			TEC^C (Cancer) (ppm) (mg/kg)	TEC^N (Non-cancer) (ppm) (mg/kg))	$DWEC^C$ (Cancer) (ppb) (µg/L)	$DWEC^N$ (Non-cancer) (ppb) (µg/L)	Criterion - Water & Organisms (ppb) (µg/L)	Criterion - Organisms Only (ppb) (µg/L)
44	beta-BHC	319857	0.00025	-	0.019	-	0.0013	0.0014
45	beta-Endosulfan	33213659	-	2.7	-	200	9.7	10
46	Bis(2-Chloroethyl)Ether	111444	0.00042	-	0.030	-	0.02	0.06
47	Bis(2-Chloroisopropyl) Ether	108601	-	18	-	1300	400	900
48	Bis(2-Ethylhexyl) Phthalate	117817	0.033	27	2.4	2000	0.045	0.046
49	Bromoform	75252	0.10	14	7.4	1000	4.6	12
50	Butylbenzyl Phthalate	85687	0.24	590	18	43000	0.013	0.013
51	Carbon Tetrachloride	56235	0.0065	1.8	0.48	130	0.2	0.35
52	Chlordane	57749	0.0013	0.23	0.095	17	0.000022	0.000022
53	Chlorobenzene	108907	-	9.1	-	670	100	200
54	Chlorodibromomethane	124481	0.011	9.1	0.83	670	0.6	2.2
55	Chloroform	67663	-	4.6	-	330	100	600
56	Chrysene	218019	0.063	-	4.6	-	0.016	0.016
57	Copper (not addressed in this paper)	7440508	-	-	-	-	1300	-
58	Cyanide	57125	-	0.27		20	9	100
59	Dibenzo (a,h) Anthracene	53703	0.000063	-	0.0046	-	0.000016	0.000016
60	Dichlorobromomethane	75274	0.013	1.4	0.98	100	0.73	2.8

40 CFR 131.45 Chemical #	Chemical Name	CAS # - 1	Tissue Exposure Concentration (TEC)		Drinking Water Exposure Concentration (DWEC)		Numeric surface water criteria for use in CWA programs	
			TEC^C (Cancer) (ppm) (mg/kg)	TEC^N (Non-cancer) (ppm) (mg/kg))	$DWEC^C$ (Cancer) (ppb) (µg/L)	$DWEC^N$ (Non-cancer) (ppb) (µg/L)	Criterion - Water & Organisms (ppb) (µg/L)	Criterion - Organisms Only (ppb) (µg/L)
61	Dieldrin	60571	0.000029	0.023	0.0021	1.7	0.00000007	0.00000007
62	Diethyl Phthalate	84662	-	360	-	27000	200	200
63	Dimethyl Phthalate	131113	-	4600	-	330000	600	600
64	Di-n-Butyl Phthalate	84742	-	46	-	3300	8	8
65	Endosulfan Sulfate	1031078	-	2.7	-	200	9	10
66	Endrin	72208	-	0.14	-	10	0.002	0.002
67	Endrin Aldehyde	7421934	-	0.14	-	10	0.034	0.035
68	Ethylbenzene	100414	-	10	-	730	29	31
69	Fluoranthene	206440	-	18	-	1300	6	6
70	Fluorene	86737	-	18	-	1300	10	10
71	gamma-BHC (Lindane)	58899	-	2.1	-	160	0.43	0.43
72	Heptachlor	76448	0.00011	0.046	0.0081	3.3	0.00000034	0.00000034
73	Heptachlor Epoxide	1024573	0.000083	0.0059	0.0061	0.43	0.0000024	0.0000024
74	Hexachlorobenzene	118741	0.00045	0.37	0.033	27	0.000005	0.000005
75	Hexachlorobutadiene	87683	0.011	0.14	0.83	10	0.01	0.01
76	Hexachloro-cyclopentadiene	77474	-	2.7	-	200	1	1
77	Hexachloroethane	67721	0.011	0.32	0.83	23	0.02	0.02

40 CFR 131.45 Chemical #	Chemical Name	CAS # - 1	Tissue Exposure Concentration (TEC)		Drinking Water Exposure Concentration (DWEC)		Numeric surface water criteria for use in CWA programs	
			TEC^C (Cancer) (ppm) (mg/kg)	TEC^N (Non-cancer) (ppm) (mg/kg))	$DWEC^C$ (Cancer) (ppb) (µg/L)	$DWEC^N$ (Non-cancer) (ppb) (µg/L)	Criterion - Water & Organisms (ppb) (µg/L)	Criterion - Organisms Only (ppb) (µg/L)
78	Indeno (1,2,3-cd) Pyrene	193395	0.00063	-	0.046	-	0.00016	0.00016
79	Isophorone	78591	0.48	91	35	6700	27	110
80	Methyl Bromide	74839	-	9.1	-	670	300	2400
81	Methylene Chloride	75092	0.23	2.7	17	200	10	100
82	Methylmercury (not addressed in this paper)	22967926	-	-	-	-	0.03	-
83	Nickel	7440020	-	9.1	-	670	80	100
84	Nitrobenzene	98953	-	0.91	-	67	30	100
85	N-Nitrosodimethylamine	62759	0.0000090	-	0.00065	-	0.00065	0.34
86	N-Nitrosodi-n-Propylamine	621647	0.000065	-	0.0048	-	0.0044	0.058
87	N-Nitrosodiphenylamine	86306	0.093	-	6.8	-	0.62	0.69
88	Pentachlorophenol	87865	0.0011	2.3	0.083	170	0.002	0.002
89	Phenol	108952	-	270	-	20000	9000	70000
90	Polychlorinated Biphenyls (PCBs)	n	0.00023	0.0091	0.017	0.67	0.000007	0.000007
91	Pyrene	129000	-	14		1000	8	8
92	Selenium	7782492	-	2.3	-	170	60	200
93	Tetrachloroethylene	127184	0.22	2.7	16	200	2.4	2.9
94	Thallium	7440280	-	0.031	-	2.3	1.7	6.3

40 CFR 131.45 Chemical #	Chemical Name	CAS # - 1	Tissue Exposure Concentration (TEC)			Drinking Water Exposure Concentration (DWEC)		Numeric surface water criteria for use in CWA programs	
			TEC^C (Cancer) (ppm) (mg/kg)	TEC^N (Non-cancer) (ppm) (mg/kg))		$DWEC^C$ (Cancer) (ppb) (µg/L)	$DWEC^N$ (Non-cancer) (ppb) (µg/L)	Criterion - Water & Organisms (ppb) (µg/L)	Criterion - Organisms Only (ppb) (µg/L)
95	Toluene	108883	-	4.4		-	320	72	130
96	Toxaphene	8001352	0.00042	0.16		0.030	12	0.000032	0.000032
97	Trichloroethylene	79016	0.0091	2.3		0.67	170	0.3	0.7
98	Vinyl Chloride	75014	0.00030	1.4		0.022	100	0.02	0.18
99	Zinc	7440666	-	140		-	10000	1000	1000

ATTACHMENT 2: Proposed Category Determinations for Evaluating Fish and Shellfish Harvest

Fish and Shellfish Harvest for Non-carcinogens

Category 5 Pathways	Category 2 Pathways	Category 1 Pathways
1) The median composite sample value for any single species exceeds the non-cancer TEC (TEC^N). • A minimum of 2 composite samples for a single species is required. • A minimum of 2 exceedances for a single species is required. • The samples may come from the same or separate years. • Use only high site fidelity species.	1) Any 1 composite sample exceeds the TEC^N. • No min. sample size. • Applies to both high and low site fidelity species.	1) Median of composite samples does not exceed the TEC^N. • Requires 2 or more composite samples from a single species. • Requires 2 or more non-exceedances. • Must be upper trophic level of edible species (except for PAHs) • Use only high site fidelity species.

Fish and Shellfish Harvest for Carcinogens

Category 5 Pathways	Category 2 Pathways	Category 1 Pathways
1) The median composite sample value for any single species exceeds the non-cancer TEC (TEC^N). Applies to a subset of 36 carcinogens. • A minimum of 2 composite samples for a single species is required. • A minimum of 2 exceedances for a single species is required. • The samples may come from the same or separate years. • Use only high site fidelity species. **Or** 2) All carcinogens: The median composite sample value for any single species exceeds the cancer TEC (TEC^C) AND the parameter exceeds the $DWEC^C$ in >10% of water samples OR exceeds the sediment quality standard (SQS) in one or more sediment samples. • A minimum of 3 composite samples from a single species is required. • A minimum of 3 exceedances for a single species is required. • Samples must come from 2 or more years. Time span between first and last exceedance must be 48 months or more.	*1)* Any 1 composite sample exceeds the TEC^N. Applies to a subset of 36 carcinogens. • No min. sample size. • Applies to both high and low site fidelity species. **Or** 2) All carcinogens: 2 composite samples exceed the TEC^C. • Applies to both high and low site fidelity species.	1) All carcinogens: Median of composite samples does not exceed the TEC^C. • Requires 3 or more composite samples from a single species. • Requires 3 or more non-exceedances. • Must be upper trophic level of edible species (except for PAHs) • Use only high site fidelity species.

ATTACHMENT 3: Proposed Category Determinations for Evaluating Domestic Water Supply

Domestic Water Supply for Non-carcinogens		
Category 5 Pathways	**Category 2 Pathways**	**Category 1 Pathways**
1) >10% of sample values exceed the non-cancer DWEC ($DWEC^N$). • Min. sample size: 2 or more samples collected in the ten year assessment window. The time span between the first and last exceedance must be more than 12 or more months. • There must be a minimum of two exceedances.	1) Any single value exceeds the $DWEC^N$. • No min. sample size. • No timespan requirements.	1) ≥90% of sample values do not exceed the non-cancer $DWEC^N$. • Minimum sample size =25. • Samples needed from 3 separate years in a ten year period.

Domestic Water Supply for Carcinogens		
Category 5 Pathways	**Category 2 Pathways**	**Category 1 Pathways**
1) >10% of sample values exceed the non-cancer DWEC ($DWEC^N$). Applies to a subset of 36 carcinogens. • Min. sample size = 2 • There must be a minimum of two exceedances. **Or** 2) All carcinogens: The median sample concentration (i.e. ≥50% of sample values) is above the cancer DWEC ($DWEC^C$) AND the parameter has been detected in one or more fish/shellfish tissue samples. • Min. sample size = 5. • Time span between first and last exceedance must be more than 24 months.	1) Any single value exceeds the $DWEC^N$. Applies to a subset of 36 carcinogens. • No min. sample size. • No timespan requirements. **Or** 1) All carcinogens: Greater than 10% of samples exceed the $DWEC^C$. • There must be a minimum of two exceedances. • No timespan requirements.	1) All carcinogens: ≥90% of sample values do not exceed the non-cancer $DWEC^C$. • Minimum sample size =25. • Samples needed from 3 separate years in a ten year period.