Tualatin River Basin
Rapid Stream Assessment Technique (RSAT)

Watersheds 2000 Field Methods

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Adapted from
Rapid Stream Assessment Technique
(RSAT) Field Methods 1996

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I. Introduction

The Tualatin Basin Rapid Stream Assessment Technique (RSAT) was developed to provide a concise and accurate watershed scale assessment of stream health. This version of the assessment was modified to meet the needs of the Watershed 2000 inventory. The information gathered from the inventory is being used to address both Clean Water Act and Endangered Species Act issues facing the Tualatin Basin.

The assessment represents an adapted version of Metropolitan Washington Council of Government's RSAT (1996), which was a synthesis of US Environmental Protection Agency's Rapid Bioassessment Protocols (Plafkin, et. al. 1989), the Izaak Walton League and Save Our Streams stream survey techniques (Kellog, 1992), US Department of Agriculture Water Quality Indicators Guide: Surface Waters (Terrell and Perfetti, 1989), together with input from ecology professionals with many years of local stream survey experience.

RSAT has been intentionally designed to provide a simple, rapid reconnaissance-level assessment of stream quality conditions and potential enhancements that may improve stream health. Major abiotic and biotic factors which influence overall stream quality have been placed into the nine following general RSAT evaluation categories:

1. Stream Flow Characterization
1. Stream Cross Section Characterization
1. Stream Channel Characterization
1. Water Quality
1. Physical In-Stream Habitat
1. Streamside Corridor Characterization

1. Casual Observations of Biological Indicators
1. Project Opportunities
1. Culverts and Stormwater Outfalls

The field protocols outlined in Section II provide further detail regarding the methods of measurement and analysis of the categories noted above. Section III contains the data sheets and supporting reference sheets needed to complete the RSAT's. Section IV and V contain plant community references and model project elements, respectively.

Assessment Qualifications
The assessment work should be performed by a professional trained in the field of hydrology, soil science, geomorphology, botany, fish/macroinvertebrate biology, ecology or other related science discipline.

I. Tualatin Basin RSAT Field Protocols

The protocols described herein represent an attempt to provide both general guidance and standardized procedures for "reading" the stream for tell-tale signs of overall quality and level of impairment. In addition to calibrating and properly maintaining water quality meters and other field equipment, it is important that RSAT survey team members calibrate their eyes by reviewing other sites in the watershed and cross-comparing evaluation scores. Where more quantitative or intensive data is needed for study purposes (e.g., pebble count for enumerating substrate particle size) RSAT may be modified to accept the needed accommodation(s).

The RSAT employs a rigorous field evaluation protocol in which over 50 physical, chemical and biological parameters are measured. The RSAT *transect* includes the stream as well as the adjacent stream buffer which consists of the riparian corridor and /or floodplain. The RSAT *length* represents information gathered up and downstream of the RSAT *transect*, and was measured to be 2 x bankfull width at the transect x 10 feet. The findings for the RSAT *transect*, along with the RSAT *length* are then linearly applied to the *stream reach* where the riparian and geomorphic conditions are represented by the RSAT information. Multiple RSATs must be gathered along the stream as the riparian and / or geomorphic conditions change, in order to adequately represent the stream being studied. All the gathered information is transferred into a database and geographic information system (GIS). All the locations of field information collection are electronically logged by a global positioning system (GPS), to allow for repeat analysis at the same location in the future. The details of protocol elements are outlined in sections A-G.

A. Field Survey Preparation, Planning, and Data Organization

1. *Field Work Timing*

The assessment is best conducted between July and October, when stream flows are low and channel characteristics are visible. If significant storms occur over the course of the analysis, field work should be suspended until the stream returns to “normal” low flow conditions.

2. *In-House Preparation*

Before heading out to the stream, the following preparatory map work and planning is recommended:

a. Review existing watershed management plan, aerial photography, and stream water quality data, if available.

b. Identify the stream(s) to be studied and determine their RSAT nomenclature per Table 1. Assign a nomenclature, if none is available for the stream. Check to ensure the abbreviation is not already being used by another stream.

b. Using a US Geological Survey 7.5 minute series quadrangle topographic map, watershed plan map or equivalent, delineate the drainage area at the furthest downstream point to be surveyed. Then using either a planimeter, dot grid, or geographic information system (GIS) calculate the associated drainage area;

b. Determine the general watershed land use(s) and approximate overall imperviousness level for the survey area using, whenever available, recent county/state zoning and land use maps or watershed plan information;

b. Orient yourself with the RSAT definitions: *Transects* are the sampling locations perpendicular to the stream and extend out to the outer floodplain or buffer area. *RSAT length* is the sampling area along the stream, upstream and downstream of the transect station with the extent based on the channel width x 10 feet. *Stream reach* is the geomorphically and ecologically discrete unit along the stream in which the RSAT transect and length data is applied (Figure 1).

b. Pencil-in and number the proposed RSAT transect onto a suitable topographic base map. RSAT transects should be spaced in order to adequately represent changes in the stream reach's geomorphic and ecologic condition. Note the extent of the transect which is 200 feet outward from either side of the riparian area or its floodplain, whichever is greater. The exact location should be modified based on field observations. Temporarily number the RSAT's in an upstream-downstream order. Note that property access may dictate a change in the numbering pattern based on availability.

b. The average stream gradient for the proposed survey segment should be determined directly from the topographic base map(s) and eventually noted / confirmed on the data sheet. Gradient is calculated by dividing the elevation difference between the start and end points by the total stream segment length to be surveyed.

b. Consult site access maps DAILY to determine properties where access has been denied. Review your RSAT transects, and modify them to accommodate access considerations. Contact property owners requesting confirmation prior to accessing their property. Areas inside the urban growth boundary may be accessed along local sanitary easements. IN AREAS OUTSIDE THE URBAN GROWTH BOUNDARY, DO NOT ACCESS PROPERTIES THAT HAVE DENIED OR UNKNOWN ACCESS.

Figure 1 - RSAT Measurements

Table 1 Stream Nomenclature

Fanno Basin
Ash – AS
Ball – BL
Derry Dell – DD
Fanno Lower - FL
Fanno Middle – FM
Fanno Upper – FU
Hiteon – HN
Krueger – KR
Pendelton – PN
Red Rock – RR
Summer – SM
Slyvan – SV
Vermont – VT
Woods – WD

Rock Creek Basin
Abbey – AB
Beaverton Upper – BVU
Beaverton Lower - BVL
Bethany Lake Trib – BLT
Bronson – BR
Bannister- BRT
Cedar Mill – CM
Dawson-DN
Golf – GF
Hall – HL
Holcolmb - HC
Johnson North – JN
Johnson South – JS
Reedville – RV
Rock Lower – RL
Rock Middle – RM
Rock Upper – RU
Turner - TR
Willow North Fork–WN
Willow South Fork – WS

Tualatin Tribs
Butternut – BN
Gordon – GN
Cross – CR

South County
Saum – SA
Nyberg – NG
South Rock – SR
Chicken – CN
Cedar – CD

Central County

Helvetia – HV
Mckay Trib West -MKW
Gales - GS
Dairy – DY
Glencoe Swale – GC
Council – CL
Storey – ST
Wiable– WB

3. Field Preparation

Prior to conducting the field work, the following preparation is recommended:

a. Determine the intended length of stream to be surveyed per day. Note that this will be difficult with highly variable site conditions.

b. Notify fellow workers of your location and expected return. Carry a cell phone and provide the phone number to staff awaiting your return.

c. Gather all necessary equipment including:

- tape measure
- survey rod
- data sheets, reference sheets and pencils
- densiometer
- GPS unit
- Water quality probe and calibration materials
- water quality sample bottles and label marker
- cork
- viewing tube
- hip or chest waders / field vest
- digital camera
- pocket knife
- flagging
- preparation and access maps
- aerial photo

d. Familiarize yourself with the data sheet and reference sheets. Note that when left and right side parameters are to be recorded separately, left and right are defined as the examiner faces downstream. Digital photographic information of the RSAT transect is catalogued so as to provide a permanent historical reference for areas surveyed. The photo is to be taken in the downstream direction, framing in both banks of the stream and capturing as many of the landscape features as possible.

e. Familiarize yourself with the global positioning system (GPS) you are to use to log the transect locations, presence of stormwater outfalls, culverts, fish barriers, project enhancement opportunities, and other noteworthy observations. The accuracy of the GPS shall be within 1 meter. Be sure triangulation and point recording occurs before moving on to the next location. In the event of tree canopy that impairs the GPS, move to a clearing and note the offset on the unit or on the data sheet as appropriate.

f. Familiarize yourself with the water quality probe to be used. Calibrate the instrament as needed to get accurate pH, dissolved oxygen, conductivity, and temperature readings.

4. *Data Organization*

Upon return from the field, the data and GPS points should be downloaded into the Excel or other database, and GIS layers accordingly.

Creation of RSAT GIS layer

1. Field crews used MC GPS units from Corvallis Microtech.
2. Field crews stood on the spot where they were conducting data collection for the RSAT and took a GPS reading. They collected point data on regular intervals. A unique ID was assigned to each RSAT collection area while in the field.
3. The data was downloaded from GPS onto computers on a weekly basis. Converted GPS data into point theme shapefile using ArcView.
4. Ecological data collected at each RSAT point was entered into a spreadsheet. This data was joined to the point theme of RSAT locations by it's unique ID.

A. **Stream Flow Characterization**

Information on stream flow is often available in watershed plans or their associated technical appendices. Stream gage information is also available from the Washington County Water Master or USGS. If stream flow gage or modeling information is not available for the area, the following procedures for estimating velocity and volume are provided below.

Under the RSAT procedure, baseflow discharge is estimated in the vicinity of the furthest downstream transect station using the Embody Float Method (Embody, 1929). Selection of a stream area which has relatively uniform cross-section, bed material size and velocity/depth characteristics is critical to achieving consistent results. Field measurements of both velocity and rate of flow are made as follows:

Velocity

Locate two points four feet apart (or any convenient distance) and mark both the upstream and downstream ends with a rock or some other convenient object. Using a small, round cork float record the time it takes for the float to drift between the two points. Repeat this three times, making sure that representative velocity areas are floated. Record the average time. Calculate the number of feet traveled per second by dividing the average time in seconds into the distance traveled.

Volume of Flow/Discharge

The following formula is used to calculate discharge:

$$R = \frac{WDaL}{T}$$

Where: R = volume of flow in cubic feet per second (cfs);
W = average wetted perimeter of stream in feet;
D = average stream depth in feet;
a = roughness coefficient – smooth sandy bottom = 0.9, rough rocky bottom=0.8;
L = length of stream floated; and
T = time in seconds for float to travel the measured distance.

When properly applied the preceding method yields consistent results. However, a word of caution is warranted. Flows generated by the Embody Float Method are generally consistently higher than those obtained from either a flow meter or a V-notch broad-crested weir. Velocity measurements may be difficult in some reaches due to lack of water or water movement during the summer months. When there is water, but no flow, mark a zero (0) on the sheet. When no water is present mark four nines (9999) on the data sheet.

C. Stream Cross Section Characterization

Cross section information is recorded at a transect perpendicular to the stream**.** As seen in Figure 2, eight different parameters are measured at each ***RSAT transect***. Because the associated data provides the requisite baseline for both planning-level analyses of general channel morphology and hydrologic conditions, it is imperative that a representative transect location be selected where possible. A brief description of how each cross-sectional parameter is measured or recorded, and their general relevance is provided in the following section. Note, all channel morphology parameters are measured to the nearest tenth of a foot.

Bankfull Width

Bankfull width is measured from left bank to right bank at a height determined by the high water mark, which is distinguished by a break in the general slope of the bank or general lack of vegetation along the bank. Measure from top of bank to top of bank when bankfull height is equivalent to overbank height. In order to minimize potential measuring error the tape measure is both held level and pulled taut. Bankfull width provides insight into the relative volume of discharge associated with large bankfull storm event (i.e., approximately 1.1-1.5-year frequency storm).

Bed Width

Bed width is measured from toe of left bank to toe of right bank across the channel and is generally marked by the lowest noticeable break in slope of the bank; it will include part or all of the active channel area. This parameter provides insight into the relative volume of discharge from smaller, more frequent storm events (i.e., generally ≤ 1-year frequency storm).

Wetted Width

Wetted width is the portion of the channel which contains flowing water and is measured from water edge to water edge along the transect. When compared with bottom channel width, wetted width provides insight into both level of stream channel widening and existing physical aquatic habitat.

Average Wetted Width/Depth

Average wetted width / depth is the water depth of wetted channel at RSAT transect. A minimum of three measurements should be taken. This parameter is used in the calculation of water volume at the time of the survey.

Maximum Bankfull Depth

Maximum bankfull depth is measured from the thalweg of the channel (the deepest point across the channel) to the height of bankfull width. This is an indication of water depth during the average high water flow event.

Over Bank Height

Overbank height is measured from stream water surface to the top of each bank. This measurement is performed separately for each bank. Note that the bankfull and overbank height may be difficult to assess where the stream channle is part of a swale or wetland.

Bankfull Height

Bankfull height is measured vertically from stream water surface to bankfull width height. This measurement provides insight into the approximate extent of stream channel downcutting. Note, bankfull depth is measured from below the water surface and bankfull height from the water surface.

Bank Angle Ratio

Bank angle ratio is a measure of the horizontal to vertical measurement of the stream bank. It is recorded as a ratio such as 3H:1V on the data sheet or may be converted to a percentage such as 33%. Recorded separately for each bank, this is a measurement of the relative steepness of the bank.

Figure 2: RSAT Transect Channel Measurements

D. Stream Channel Characterization

The total length of stream to be included for measurement and estimation of the RSAT parameters at each transect is defined as the RSAT length. RSAT length is determined by the formula 10 feet x Bankfull Width x 2. For example, in a transect with a bankfull width of 10 feet, the RSAT length is, 10x10x2, or 200 feet.

Valley Profile

Valley profile is a generalized landscape scale parameter that examines the stream channel valley in a cross-sectional view. The four profile options are; U-shaped valley, V-shaped valley, ponded or floodplain.

Reach Channel Gradient

Reach Channel gradient is measured at three points over the RSAT length using a survey scope and rod or clinometer. Measure the change in elevation with the rod being placed in the thalweg, but not in overly deep pools (greater than twice the average depth of the stream) or shallow riffles. Gradient may also be determined via topographic mapping if detailed stream survey cross sections are being conducted (in the case of all FEMA study areas).

Bank Material

Bank material is the soil type of the stream bank. Along the RSAT length of each transect, the general soil texture of material located in the lower one-third of each bank is classified by general soil type. The following three general classes are used; silt, clay, bedrock, other impermeable material.

Depending on the degree of homogeneity of the bank material, more than one sample may need to be examined. The general class is then recorded on the survey form. Bank material information is used for: 1.) quick screening of the relative potential erodibility of the stream bank network and 2.) providing insight into both potential in-channel sources of sandy material and possible future susceptibility to high embeddedness levels.

Bank Stability and Undercut Banks

Bank stability is a percentage measure of the erosion along a stream bank. Within the designated RSAT length both right and left banks are carefully examined for signs of bank instability. Signs of instability such as bank sloughing/slumping, recently exposed non-woody tree roots (e.g., fine hair-like roots and or smaller lateral roots measuring less than 0.5 inch in diameter), the general absence of any vegetation within the lower one-third portion of the bank, recent tree falls, etc. are noted. After the percent of unstable area for each bank has been determined it is recorded along with the average percent of undercut bank area.

Bed Downcutting

Bed downcutting is a measure of erosion occurinning in the channel bed. As the RSAT length is walked, note evidence of major channel downcutting or bed degradation. Again, average bank heights provide a good approximate indication for most streams. Other reliable indicators include the presence of nickpoints and exposed concrete footers for retaining walls, weirs, culverts and other man-made instream structures. In urban streams, the presence of exposed sewer lines provide a good measure of channel degradation. Note the number of sewer lines or other normally buried utility lines observed and record on the stream survey form. Determine the percentage of the RSAT length that is experiencing downcutting.

Dominant Bed Material

The dominant size class of material found in the bed of the stream is classified in accordance with the textural characteristics described in Table 2. Depending on the degree of homogeneity of the bed material, more than one sample may need to be examined along the RSAT length. The dominant textural class is then recorded on the survey form. Do not confuse deposition material with bed material. In areas of active sediment deposition the actual bed may be buried by more recent deposits. In low gradient streams, where the levels of deposition make it impossible to determine the bed material, the deposition material is the bed material.

For aquatic habitat, the ideal riffle substrate composition is (in descending order) a cobble, gravel, rubble, boulder mix with little sand.

Table 2. General RSAT Substrate Size Classes (modified from Wentworth, 1962)

Class (Abbreviation)	Particle Size Range Mm	Particle Size Range inches
Boulder (B)	>305	>12
Rubble (R)	256-305	10-12
Cobble (Cb)	64-256	2.5-10
Gravel(G)	2-64	0.1-2.5
Sand(S)	0.062-2	<0.1
Clay(C)	<.062	

Deposition Material

Deposition material is the sediment type that deposits in the pools and benches of the stream. In areas of active sediment deposition, dominant substrate material is broadly classed as silt, sand, gravel, or none. The presence of the dominant material is recorded and the average depth of deposition is recorded to the nearest 0.1 foot. The percentage of the RSAT length with significant depositional material (.25 foot and greater) is also noted on the data sheet.

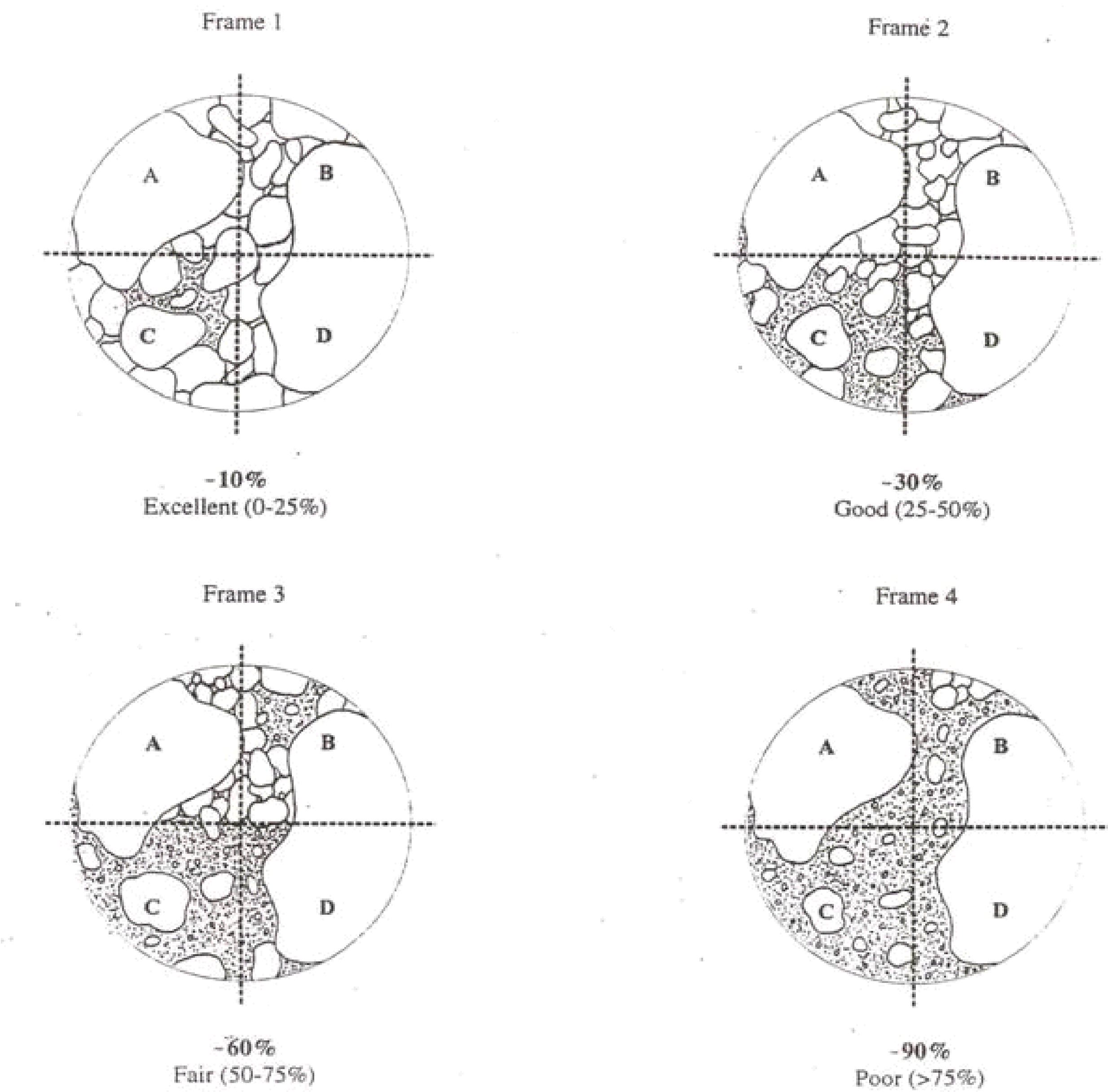
Embeddedness (Percent fines)
Embeddedness is generally defined as the degree to which sand and silt (fines) surround or cover the larger gravel, cobble and boulder-sized material in riffle areas. The embeddedness measurement shall occur at a representative riffle within the RSAT length. Mark N/A if the RSAT length does not contain any riffles.

The percentage of fines occupying the interstitial spaces between cobble, gravel, rubble and boulder-sized material is visually estimated with the aid of a viewing tube. Figure 3 has been included to illustrate the four general percent embeddedness ranges/categories used in RSAT. The imaginary quadrants depicted in Figure 3 may be used as a handy reference aid in first gauging the general embeddedness range. Next, and only after closer examination, the level of embeddedness is estimated to the nearest 5 percent.

Ten viewing tube readings are taken at the representative riffle and the subsamples are averaged and the mean recorded on the stream survey form. In order to avoid both undesirable clouding of the water and potential substrate disturbance, it is recommended that measurements begin at the downstream end of the riffle and proceed in both a lateral and upstream direction (e.g., z-like pattern).

Two sizes of viewing tubes, each with a white surfaced interior are recommended: a.) for shallow riffles measuring less than six inches deep – a minimum 10-inch long tube with a six-inch internal diameter, and b.) for riffles over six inches deep - a standard, white five-gallon plastic bucket with both the bottom-end cut out and a small siphoning notch cut into the bottom edge.

Figure 3: Riffle Substrate Embeddedness



= sand/silt-sized material (fines)

[1] Bolded number below each frame is areal percentage of fines surrounding larger bed materials; imaginary quadrants labelled A, B, C, D used as handy reference aid.

D. **Water Quality**

Substrate Fouling

Substrate fouling is defined as the percentage of the underside surface area of a cobble-sized stone (or larger), woody debris or other object lying free on the streambed, which is coated with biological film or growth. Substrate fouling level is determined at one representaive riffle or area where fouling is occurring along the RSAT length by turning over and visually examining the underside of 10 appropriately sized rocks, small woody debris, or other material found in the stream. The recommended procedure is to first visually divide the underside surface of each object into four equally spaced quadrants. Within each quadrant the observer mentally notes the areal extent of biofilm coverage to the nearest 5 percent. Each quadrant is examined in similar fashion, with the sum percentage of the four quadrants used to assign an average overall substrate level percentage to the individual object. The same procedure is then repeated for each of the 9 remaining objects. After all 10 objects have been examined the mean substrate fouling level (for the 10 subsamples) is recorded. Representative substrate fouling levels as determined by the preceding method are illustrated in Figure 4.

Substrate fouling provides a qualitative indirect measure of chronic nutrient (primarily nitrogen) and organic carbon loadings in a stream. In relatively clean streams substrate fouling levels are normally on the order of 10 percent or less (Galli, 1995).

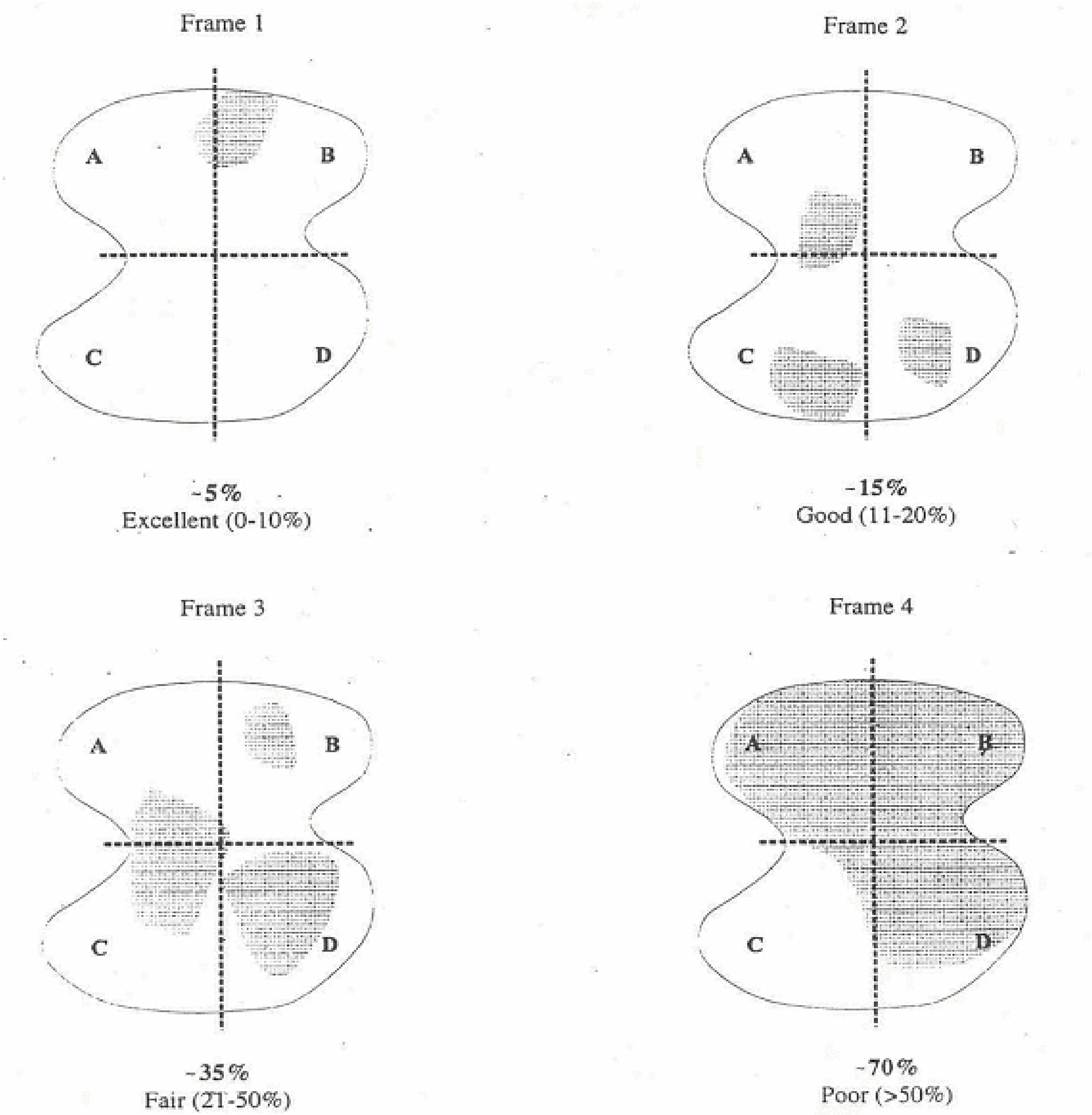
Water Quality Meter Readings, Color and Odor

The following nine parameters are measured at every RSAT transect: air temperature, water temperature, dissolved oxygen (DO) percent saturation and parts per million (PPM), conductivity, pH, water color and odor. A multi-parameter water quality meter is used to measure dissolved oxygen, conductivity and pH. The meter is to be maintained, calibrated and used in the field in accordance with the manufacturer’s instructions in order to ensure data accuracy and consistency between field teams. Water color and odor are described according to the general terminology presented in Tables 3 and 4. Water quality information is available for representative streams in the Basin. Contact DEQ or Clean Water Services for background information, as needed.

Presence of Algae

The presence or absence of algae in the RSAT length is based on visual observation. If algae is present the relative abundance is recorded as: isolated occurrences (on the edges, <20% coverage over the length), moderately abundant (blooms in small to mid size patches covering 21-50% of the length) , or abundant (large blooms covering >50% of the length).

Figure 4: Substrate Fouling



= biofilm area (i.e., coating on underside of stone associated with growth of bacteria, fungi, slime molds or combinations thereof).

[1] Bolded number below each frame is percent substrate fouling; imaginary quadrants labelled A, B, C, D used as handy reference aid.

Table 3. List of RSAT Water Clarity and Color Terms

Clarity/Color	General Description
1. Clear	Smaller objects lying on streambed in deeper pool areas (i.e., $\geq$ 3 feet deep) clearly visible.
2. Slightly Off-Color	Water has slight yellow, brown or greenish hue. Visibility of smaller objects lying on streambed in deeper pool areas are partially obscured. Larger objects still visible.
3. Off-Color/Turbid	Visibility into water column is nil. Generally attributable to high levels of light scattering/reflecting particles in water column such as clays, algae, etc.
4. Tea or Coffee	Self-describing. Generally associated with tannic and fulvic acids from decomposition of leaves or other organic material. More common during fall-winter seasons. May sometimes be associated with seasonal growths of certain algae on streambed.
5. Bright Green	Most likely source is antifreeze. Note, uranine dye is (bright green) an additive in antifreeze.
6. Green	Fibrous, slime layers with visible air bubbles may indicate an algae bloom brought on by excess nutrients. The most frequent cause is improper fertilizer or manure storage and/or application.
7. Yellow-Brown, Sudsy	Suds normally observed in slower eddy areas. Origins may be tree resins, gums and/or pollen.
8. Red-Orange	Filmy deposits along the edge of the stream and bed often associated with greasy rainbow appearance of iron-oxidizing bacteria (which are generally naturally occurring).
9. White, Cloudy	If there are no identifiable solids or odor, it is likely that this problem is run-off from cement cutting or washing activities associated with roadway construction.
10. White, Sudsy	Usually associated with home car washing, or other detergent discharge. Most car washes recycle their wash water and have discharge permits with established limits. Note, car wash discharges will normally have waxy smell.

11. Light to Dark Gray	Strong fetid odor indicates possible sewage overflow or exfiltration. Sewer trunk lines and manholes follow stream valleys to treatment plants and may occasionally leak or overflow with time or during certain large stormflow conditions. Note, sewage fungus growth on rocks in stream provides additional evidence.
12. Brown	Probable discharge of sediment-laden water.
13. Yellow-Brown	Greasy petroleum smelling material that clumps together is likely to be Number 2 fuel oil.
14. Rainbow Sheen	Oils which coalesce together when disturbed indicate a petroleum discharge.

Table 4. List of RSAT Odor Terms

Term	**Descriptors**
1. None	**no smell**
2. Organic	**earthy, soil**
3. Chlorinated	**bleach, chorine**
4. Petroleum	**Gas, oil**
5. Antifreeze	**sickly sweet**
6. Sulfurous	**rotten eggs**
7. Sewerage	**Foul**
8. Other	

Water Quality Sampling

In RSAT lengths, where one or more of the water quality parameters, or best professional judgement, suggests problems within the water quality beyond normal urbanization effects, it may be appropriate to collect a water sample and submit it to the CWS Water Quality Laboratory for further analysis. If samples are collected they should be noted on the survey and the coordinates GPS located. Samples should be collected in clean, Chem-certified bottles. The bottles should be clearly labeled with the RSAT number, a description of the sampling location, and the parameters which they are to test for (ie oil and grease, sewerage, bacteria, etc). Keep samples cold at 4 degrees Celsius and delivered to the lab within 8 hours of collection.

D. **Physical In-Stream Habitat**

Riffle Substrate Material

In RSAT lengths containing riffles, the riffle area is surveyed and the percent cobble substrate is visually determined. The average riffle depth (in inches) is also recorded.

For aquatic habitat, the ideal riffle substrate composition is (in descending order) a cobble, gravel, rubble, boulder mix with little sand. In general, as the amount of sand increases, habitat conditions for both macroinvertebrates and for fish spawning and incubation decline. Note, fair to poor conditions are generally present when sandy material appears in one of the first three particle size slots recorded on the stream survey form.

Riffle/Pool/Glide Ratio

Estimate the percent coverage of riffle, pool and glide habitat over the RSAT length. The ratio provides a relative measure as to the general mix of instream fish habitat present. In addition, the number of riffles and pools present are each counted.

Large Wood or Log Jam Presence

For each RSAT length evaluate the presence of large wood (LW) and/or log jams. Large wood consists of trees 6 inches in diameter and greater, and of adequate length and size to remain in the vicinity of its current placement, except in large storm events (localized mobility). In areas of abundant LW these large storm events can create log jams within the stream channel. The greater the amount of LW or log jams, typically the more habitat complexity in the Tualatin River Basin. The number of LW is recorded independent of the number of log jams.

D. **Streamside Corridor Characterization**

The following field methods are for determining the overall condition of the streamside habitat. The analysis does not replace the requirement for completing the vegetated corridor condition assessment per CWS's Design and Construction Standards.

1. **Streamside Condition**

Buffer Width

At each RSAT transect the streamside buffer width along the left and right bank are visually estimated. The streamside buffer is the zone that actively influences and is influenced by the stream hydrology and geomorphology; it typically extends a tree height beyond the meander zone of the stream in lower gradient streams and may extend 1-2 tree height potentials in mid and upper gradient reaches. Buffer widths are averaged over the RSAT length and recorded on the survey form to the nearest 5 feet. This existing buffer estimate should not be confused with or interpreted as satisfying or meeting the vegetated corridor requirement per CWS's Design and Construction Standards.

Vegetative Strata Complexity

At each RSAT transect, visually estimate the dominant vegetation (species covering greater than 5% area) along each bank and record on the survey form. Percent tree, shrub, groundcover and non-native/invasive cover are each estimated as if viewed from above, on a scale from 0 to 100 percent. Under this system total vegetative cover could theoretically be as high as 300 percent, if tree, shrub and groundcover are each estimated to be 100 percent. Use a 10-foot radius plot for herbs (non-woody vegetation), and a 30-foot radius plot for woody vegetation.

Tree Canopy

Use a spherical densiometer or a hand-held, 50 square plexiglass grid or equivalent to determine tree canopy cover. Measurements are taken from the center of the stream channel and are the average of 4 readings, one each from the four cardinal directions. Canopy coverage is recorded on the survey form to the nearest 5 percent. Note: an eyeball method may be substituted <u>after</u> having calibrated one's eyes with one of the preceding instruments. Also, it is recognized that canopy coverage estimates made during late fall, winter and early spring are less accurate and require considerably more effort. During these periods, close attention to riparian vegetation species composition, height, branching patterns and density, etc. is essential to making reasonable estimates.

Plant Community

Document the dominant plant community within the streamside buffer for left and right banks. The "dominated by invasives" category is for plant communities that do not meet the general character of the categories provided. The complete list of these typical plant communities is included in Section IV. The plant community types common to the Tualatin Basin include;

Mixed Riparian Forest	Headwater Forest	Upland Forest
Forested Wetland	Shrub/Scrub	Wet Meadow
Emergent Marsh	Dominated by invasives	Developed
Other (describe)		

Large Wood Recruitment Potential

A qualitative rating of the ability of the existing streamside buffer area to supply large wood into the stream system within a ten year time frame. The analysis should take into account the ability of the riparian area to maintain itself in light of adjacent land use management. Large wood recruitment potential is recorded as follows:

High	Significant quantities of mature material, evidence of recruitment in-channel already, regeneration in riparian zone occurring.

Medium	Scattered mature trees, minimal evidence of recruitment in channel, regeneration in riparian zone present
Low	Immature riparian vegetation, no recruitment evident, little to no regeneration in the riparian zone.
None	No trees present.

1. **Active Floodplain Width and Plant Community**

In areas where floodplain is present, its total width outside of the measured as part of the streamside area. The floodplain to the left and right of the stream, is recorded (see Figure 5). In addition, as in streamside areas, the dominant plant community of the floodplain is identified. In the medium and high gradient reaches of a stream, as well as in highly urbanized areas, active floodplains are not common.

1. **Outer Buffer Width and Plant Community**

The outer buffer begins just outside of the streamside areas or outside the floodplain, when present (see Figure 5). The outer buffer represents the dominant plant community separating the stream/floodplain from adjacent landscapes or development. As with the floodplain and streamside areas, the width of the community is estimated and the dominant plant community is recorded for both sides of the stream. The general landscape character immediately adjacent to the outer buffer is also recorded as either: residential, commercial/industrial, agricultural, or undeveloped.

Figure 5: Buffer Measurement

D. Casual Observations of Biological Indicators

Due to the need to move quickly through the stream system, a detailed study of biological indicators is not included in the RSAT. However, the RSAT does document in-stream and riparian habitat, and the species likely to utilize such habitat can be inferred from other more detailed scientific studies. The RSAT employs a casual observation of species, or evidence of their presence, including their habitat and numbers. The scientists may not be present at the stream at the appropriate times to document the full use by a diversity of species.

Macroinvertebrates

Macroinvertebrates are generally defined as animals without backbones that are large enough to be retained on a U.S. standard No. 3 sieve, 0.595 mm openings. Benthic macroinvertebrates have long been used for biological monitoring purposes because they are a ubiquitous diverse group of sedentary and relatively long-lived species, which often respond predictably to human watershed perturbations. Importantly, a stream's biological community normally responds to and is reflective of prevailing water quality and physical habitat conditions.

As part of the RSAT evaluations, a screening level biosurvey of the stream's riffle or large wood macroinvertebrate community is performed. The primary purpose of the biosurvey is to characterize macroinvertebrate community composition and relative abundance of major representative taxonomic groups, so as to shed additional light on overall stream quality/level of impairment.

The standard RSAT macroinvertebrate sampling protocol involves turning over 10 cobble-size stones (or larger). Macroinvertebrate identification is done at each riffle transect site via visual examination. Individuals are identified to taxonomic order (relative to the ability of the examiner) and recorded on the survey form.

Fish and Crayfish

The presence of fish and crayfish in the stream reach is based on visual observation of species and relative abundance observed during the course of the survey. Walking carefully streamside, and before conducting the macroinvertebrate sampling, is likely to yield more accurate results. If specific species are identified, note them at the bottom of the RSAT form along with the number of individuals observed.

Birds and other Wildlife Evidence

The presence of birds and other wildlife is based on visual observation of species and relative abundance observed during the course of the survey. Pay special attention to bird and wildlife presence while walking the stream reach; this will allow for a more accurate census. Observations of scat, tracks or burrows should also be noted. If possible, birds and other wildlife should be identified by scientific name (genus and species). Record an estimate of the number of individuals of each species observed.

D. **Project Opportunities**

The RSAT is designed to provide a rapid determination of stream health. In areas where the system is lacking critical elements, identify the limiting factors in the form of a project enhancement opportunity. The following is a list of potential project elements, which are further outlined in Section V. The project reaches are defined after the field work is complete and may include several elements within one project reach.

Culverts and Barriers

Culvert retrofit upstream / downstream
Culvert replacement
Obstruction / barrier removal

Channel Enhancement

Channel remeandering / pond reconfiguration
Oxbow / off-channel habitat creation
Gravel placement
Large wood placement

Bank Stabilization

Bioengineered bank stabilization
Rock placement

Vegetated Corridor Enhancement

Floodplain wetland enhancement
Streamside buffer enhancement
Outer buffer enhancement
Community tree planting

Preservation / Conservation

Acquisition / easement
Modification / removal of structures
Neighborhood education

J. Culverts / Barriers and Stormwater Outfalls

During the course of the field investigation, scientists should GPS any culverts and stormwater outfall encountered. Photos shall be taken in either direction as necessary to document any problems.

Culverts and Barriers

Investigators shall document the culvert identification, structure type, entrance zone and treatment, exist zone, passage zone (in culvert), exist zone, barrier severity, culvert treatment at exit, and overall culvert condition.

Stormwater Outfalls

Investigators shall document the stormwater identification, outfall size, condition, and adjacent land use. Notes regarding any flow, odor or other information shall also be collected.

III. Data Sheets and Reference Field Sheets

Watersheds 2000 RSAT Cheat Sheets

GPS Data Collection Options:

• RSAT point • culvert point • outfall point • misc. point (photos) • misc. line • misc. area

Stream Name Codes:

Fanno Basin
Ash – AS
Ball – BL
Derry Dell – DD
Fanno Lower - FL
Fanno Middle – FM
Fanno Upper – FU
Hiteon – HN
Krueger – KR
Pendelton – PN
Red Rock – RR
Summer – SM
Slyvan – SV
Vermont – VT
Woods – WD

Rock Creek Basin
Abbey – AB
Beaverton Upper – BVU
Beaverton Lower - BVL
Bethany Lake Trib – BLT
Bronson – BR
Bannister- BRT
Cedar Mill – CM
Dawson - DN
Golf – GF
Hall – HL
Holcolmb - HC
Johnson North – JN
Johnson South – JS
Reedville – RV

Rock Lower – RL
Rock Middle – RM
Rock Upper – RU
Turner - TR
Willow North Fork–WN
Willow South Fork – WS

Tualatin Tribs
Butternut – BN
Gordon – GN
Cross – CR

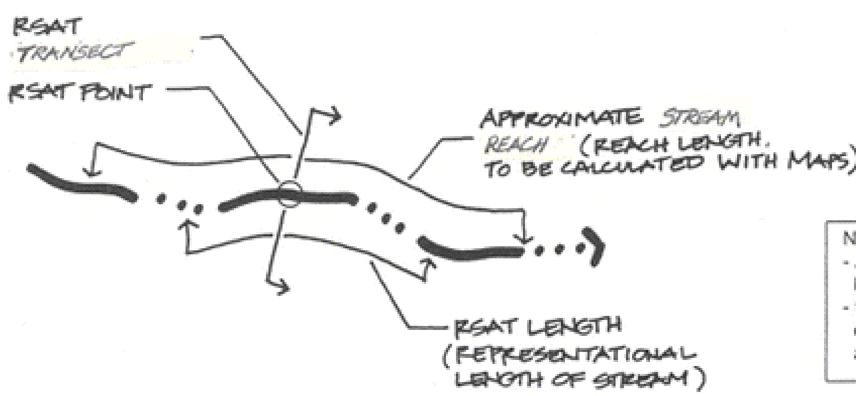
South County
Saum – SM
Nyberg – NG

South Rock – SR
Chicken – CN
Cedar – CD
Gales - GS

Central County
Dairy – DY
Council – CL
McKay – MK
Glencoe Swale – GC
Helvetia – HV
Storey – ST
MckayTrib West-MKW
Wiable – WB

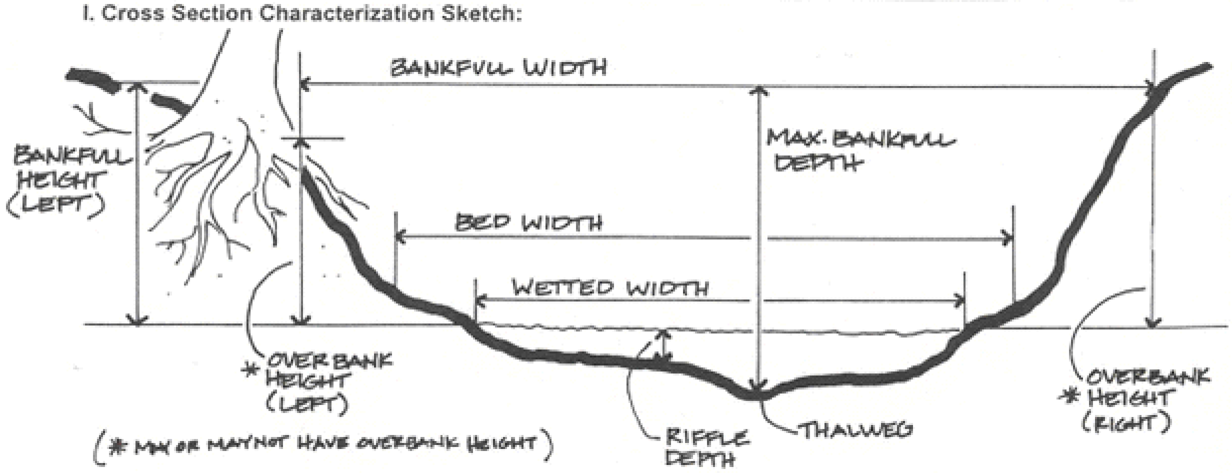
Suggested nomenclature: for example, on the main stem of Nyberg RSAT #'s would run: **NG01, NG02, NG03**... On the 1st trib encountered: **NGT101, NGT102**..., on the 2nd trib: **NGT201, NGT202**... Culverts as encountered: **NGC01, NGC02**... etc. Stormwater Outfalls as encountered: **NGS01, NGS02, etc...** *(Most importantly, be consistent and always use a unique number! To avoid duplication note numbers used on separate tracking sheet.)*

Plan View Sketch of Stream Corridor:



Notes:
- All RSAT measurements shall be taken in feet or 0.10 of feet
- the project database will calculate volume based on velocity and average wetted width

I. Cross Section Characterization Sketch:



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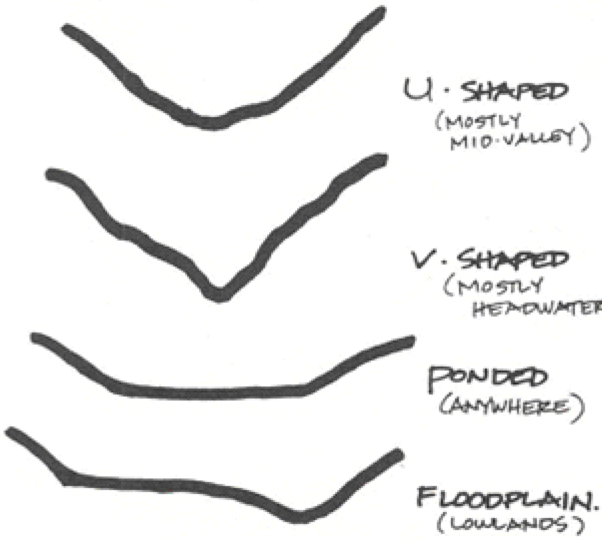
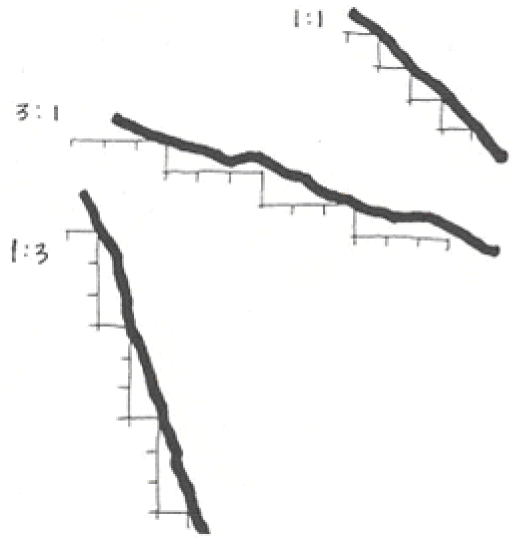
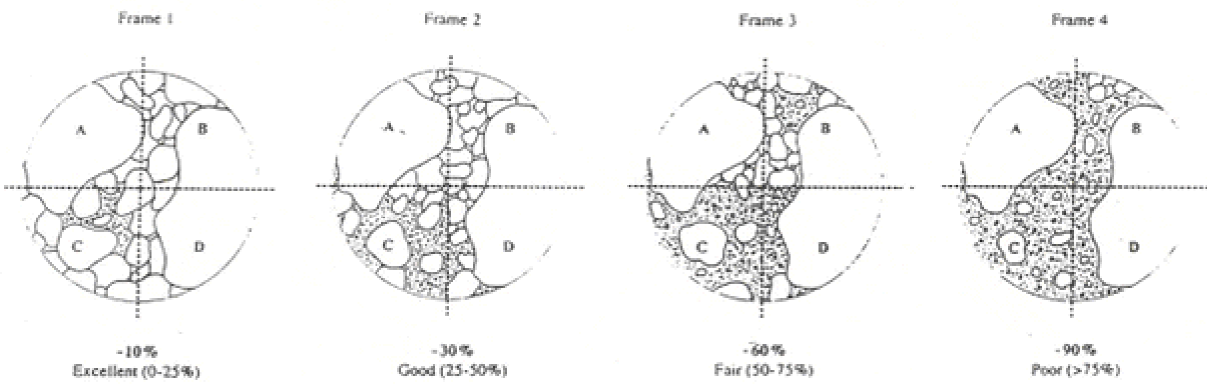
Valley Profile of Riparian Corridor:



Bank Angle Ratio:



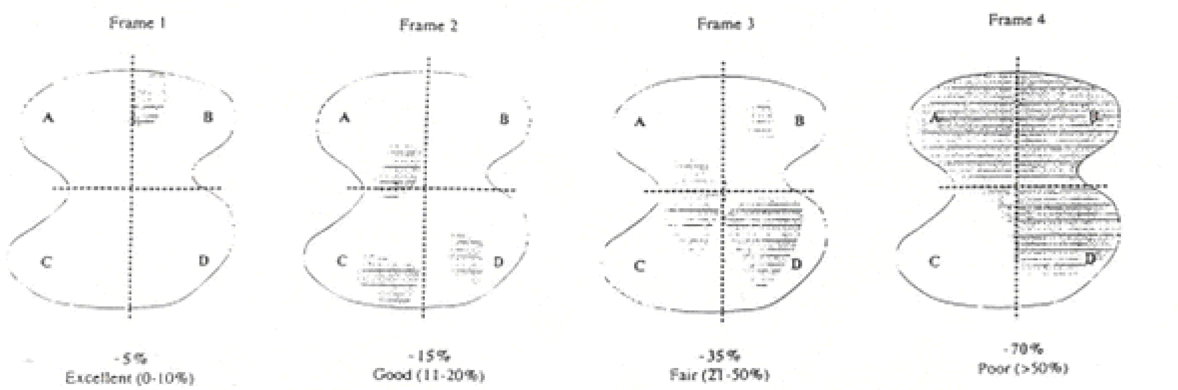
III. Riffle Substrate Embeddedness:



= sand/silt-sized material (fines)

* Bolded number below each frame is areal percentage of fines surrounding larger bed materials, imaginary quadrants labelled A, B, C, D used as handy reference aid.

IV. Substrate Fouling Levels:



= biofilm area (i.e., coating on underside of stone associated with growth of bacteria, fungi, slime molds or combinations thereof).

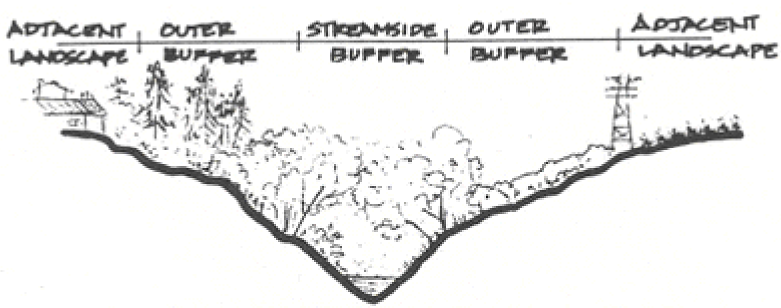
* Bolded number below each frame is percent substrate fouling; imaginary quadrants labelled A, B, C, D used as handy reference aid.

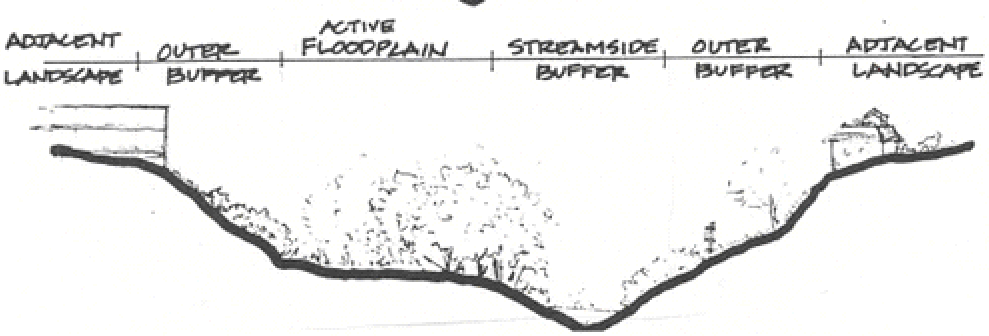
Water Clarity and Color Terms:

Table 6. List of RSAT Water Clarity and Color Terms
(modified from P.G. County Health Dept., 1993)

Clarity/Color	General Description
1. Clear	Smaller objects lying on streambed in deeper pool areas (i.e., ≥ 3 feet deep) clearly visible.
2. Slightly Off-Color	Water has slight yellow, brown or greenish hue. Visibility of smaller objects lying, on streambed in deeper pool areas are partially obscured. Larger objects still visible
3. Off-Color/Turbid	Visibility into water column is nil. Generally attributable to high levels of light scattering/reflecting particles in water column such as clays, algae, etc.
4. Tea or Coffee	Self-describing. Generally associated with tannic and fulvic acids from decomposition of leaves or other organic material. More common during fall-winter seasons. May sometimes be associated with seasonal growths of certain algae on streambed.
5. Bright Green	Most likely source is antifreeze. Note, uranine dye is (bright green) an additive in antifreeze.
6. Green	Fibrous, slime layers with visible are bubbles may indicate an algae bloom brought on by excess nutrients. The most frequent cause is improper fertilizer or manure storage and/or application.
7. Yellow-Brown, Sudsy	Suds normally observed in slower eddy areas. Origins may be tree resins, gums and/or pollen.
8. Red-Orange	Filmy deposits along the edge of the stream and bed often associated with greasy rainbow appearance of iron-oxidizing bacteria (which are generally naturally occurring).
9. White, Cloudy	If there are no identifiable solids or odor, it is likely that this problem is run-off from cement cutting or washing activities associated with roadway construction.
10. White, Sudsy	Usually associated with home car washing, or other detergent discharge. Most car washes recycle their wash water and have discharge permits with established limits. Note, car wash discharges will normally have waxy smell.
11. Light to Dark Gray	Strong fetid odor indicates possible sewage overflow or exfiltration. Sewer trunk lines and manholes follow stream valleys to treatment plants and may occasionally leak or overflow with time or during certain large stormflow conditions. Note, sewage fungus growth on rocks in stream provides additional evidence.
12. Brown	Probable discharge of sediment-laden water.
13. Yellow-Brown	Greasy petroleum smelling material that clumps together is likely to be Number 2 fuel oil.
14. Rainbow Sheen	Oils which coalesce together when disturbed indicate a petroleum discharge.

VI. Riparian Corridor Sketch:





Plant Communities Species List:

Riparian Forest

Native red alder (Alnus rubra) and/or Oregon ash (Fraxinus latifolia) and black hawthorne (Crataegus douglasii), or black cottonwood (Populus balsamifera) typically dominate the canopy, with an understory of Indian plum (Oemleria cerasiformis), Pacific ninebark (Physocarpus capitatus), red elderberry (Sambucus racemosa), Western serviceberry (Amelanchier alnifolia), vine maple (Acer circinatum), red-osier dogwood (Cornus sericea), salmonberry (Rubus spectabilis), snowberry (Symphoricarpos occidentalis), miners lettuce (Montia perfoliata), and stream violet (Viola glabella). In areas with openings in the canopy, willow species (Salix spp) and Douglas spirea (Spirea douglasii) are likely to be found.

Non-native reed canarygrass (Phalaris arundinacea) and Himalayan blackberry (Rubus discolor) typically dominate the understory of riparian forests as a result of previous disturbance.

Emergent Marsh

These wetlands contain a variety of native grass, sedge, and rush species that often form distinct patchs or zones based on the different water levels. Native species found in marsh areas include: creeping spike-rush (Eleocharis macrostachya), cattail (Typha latifolia), small fruited bulrush (Scirpus microcarpus), wapato (Sagittaria latifolia), awned-flat sedge (Cyperus aristatus), soft-stem bulrush (Scirpus tabernaemontani), giant bur-reed (Sparganium eurycarpum), water smartweed (Polygonum amphibium), American brooklime (Veronica americana), water parsley (Oenanthe sarmentosa), American water plantain (Alisma plantago-aquatica), nodding beggartick (Bidens cernua), Western mannagrass (Glyceria occidentalis), American slough grass (Beckmannia syzigachne), and common rush (Juncus effusus). Subtle changes in topography, soil conditions, and water regime determine where these species will persist.

The major non-native species that threatens the shallow areas of this habitat type is reed canarygrass (Phalaris arundinacea).

Forested Wetland

A mixture of wetland and upland species may occur in this community, depending on subtle changes in topography. Typical species include Oregon ash (Fraxinus latifolia), Pacific ninebark (Physocarpus capitatus), red-osier dogwood (Cornus sericea), slough sedge (Carex obnupta), snowberry (Symphoricarpus albus), corn lily (Veratrum californicum), small bedstraw (Galium trifidum), candy flower (Claytonia sibirica), miners lettuce (Montia perfoliata) and dewberry (Rubus ursinus). In slightly drier areas of the wetland species, such as Deweys sedge (Carex deweyana), vine maple (Acer circinatum), serviceberry (Amelanchier alnifolia), oval-leafed viburnum (Viburnum ellipticum), Oregon white oak (Quercus garryanna) and Pacific yew (Taxus brevifolia) may be present.

Non-native species threatening this wetland type include Reed canarygrass (Phalaris arundinacea) and Himalayan blackberry (Rubus discolor). Species in this wetland type that should not be touched include stinging nettle (Urtica dioica) and Western water hemlock (Cicuta douglassii).

Headwater Forest

A mixture of wetland and upland species may occur in this community, depending on topography and drainage characteristics. Typical native species include Western red cedar (Thuja plicata), Western hemlock (Tsuga heterophylla), red alder (Alnus rubra), vine maple (Acer circinatum), red elderberry (Sambucus racemosa), salmonberry (Rubus spectabilis) thimbleberry (Rubus parviflorus), sword fern (Polystichum munitum) lady fern (Athyrium filix-femina), maidenhair fern (Adianum pedatum), Cascade Oregon grape (Mahonia nervosa), false lily-of-the-valley (Maianthemum dilatatum), candy flower (Claytonia sibirica), miners lettuce (Montia perfoliata) skunk cabbage (Lysichiton americanum), and dewberry (Rubus ursinus), among others. Large woody debris and snags are also important features of this community.

Wet Meadow

Less than 0.2 percent of the historic wet meadow prairies of the Willamette Basin still exist. The prairies are dominated by tufted hairgrass (Deschampsia cespitosa) and red fescue (Festuca rubra) and flower species, including camas (Camassia spp.), montia (Montia spp), Willamette bittercress (Cardamine penduliflora), buttercups (Ranunculus spp), large-leaf avens (Geum macrophyllum), fragrant popcornflower (Plagiobothrys figuratus), narrow-leaf blue-eyed grass (Sisyrinchium idahoense), mules ears (Wyethia angustifolia), common downingia (Downingia elegans), and coyote thistle (Eryngium petiolatum). These wetlands also contain a variety of native grass, sedge, and rush species, including one-sided sedge (Carex unilateralis), slough sedge (Carex obnupta), creeping spikerush (Eleocharis palustris), meadow barley (Hordeum brachyantherum), Western mannagrass (Glyceria occidentalis), American slough grass (Beckmannia syzigachne), bentgrasses (Agrostis spp), and spreading rush (Juncus patens). Subtle changes in topography and water regime determine where these species will survive on a given site.

Non-native species that threaten this habitat type include meadow foxtail (Alopecurus pratensis), sweet vernal grass (Anthoxanthum), reed canarygrass (Phalaris arundinacea), velvetgrass (Holcus lanatus), Scotch broom (Cytisus scoparius), and teasel (Dipsacus fullonum).

Doug Fir Upland Forest
- or - Oak Upland Forest

Upland woodland species make up this plant community. Typical native species include Douglas fir (Pseudotsuga menziesii), big leaf maple (Acre macrophyllum), red alder (Alnus rubra), vine maple (Acre circinatum), bitter cherry (Prunus emarginata), beaked hazelnut (Corylus cornuta), cascara (Rhamnus purshiana), oceanspray (Holodiscus discolor), snowberry (Symphoricarpus albus), red elderberry (Sambucus racemosa), red huckleberry (Vaccinium parvifolium), thimbleberry (Rubus parviflorus), Western trillium (Trillium ovatum), Solomon's seal species (Solomon smilacina spp), sword fern (Polystichum munitum), Cascade Oregon grape (Mahonia nervosa), and saxifrage species (Mitella spp.), among others. Large woody debris and snags are also important features of this community.

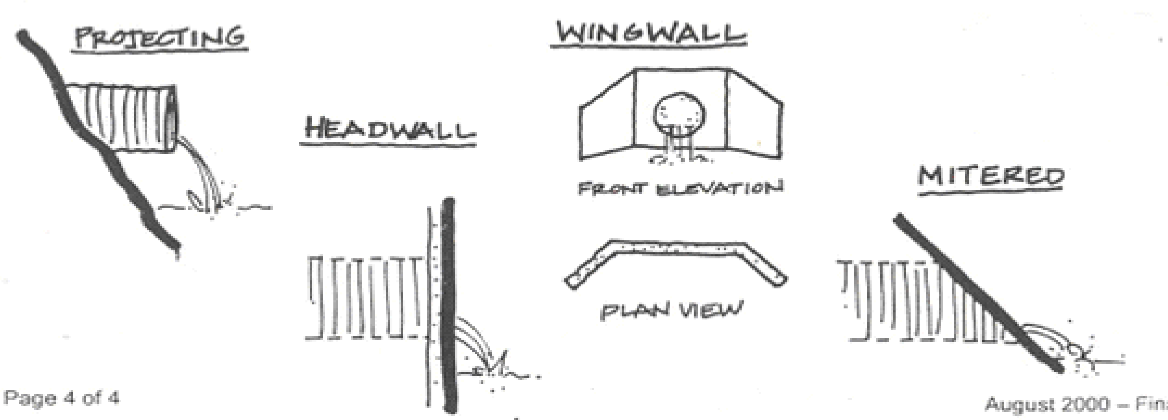
The non-native species threatening this habitat type include Himalayan blackberry (Rubus discolor), English ivy (Hedera helix), and clematis species.

Shrub/Scrub

A mixture of shrubs and herbaceous species dominate this transitional wetland type. Shrub / scrub wetlands occupy former wet prairie areas and develop successionally in the absence of fire. In instances where shrub / scrub transitions from wet meadow, the plant species are often more tolerant of drier conditions. Common species include: Nootka rose (Rosa nutkana), clustered rose (Rosa pisocarpa), serviceberry (Amelanchier alnifolia), Douglas hawthorne (Crataegus douglasii), Pacific crabapple (Malus fusca), Scoulers willow (Salix scoulerina), Pacific willow (Salix lasiandra), Sitka willow (Salix sitchensis), red-osier dogwood (Cornus sericea), Douglas spirea (Spirea douglasii), tufted hairgrass (Deschampsia cespitosa), nodding beggartick (Bidens cernua), waterpepper (Polygonum hydopiperoides), spreading rush (Juncus patens) and cow parsnip (Heracleum lanatum).

These transitional wetland areas frequently have non-native species such as reed canarygrass (Phalaris arundinacea), Himalayan blackberry (Rubus discolor), and common hawthorne (Crataegus monogyna) well established within the system.

VIII. Culvert Treatment at Exit Sketches:



See Properly Functioning Conditions Station