GEORGIA-PACIFIC OUTFALL AQUATIC COMMUNITY SURVEY

Study Plan Proposal

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Prepared for

Georgia-Pacific Toledo LLC
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Objective

Satisfy new permit conditions under Schedule D of the Georgia-Pacific, Toledo, Oregon, NPDES permit, to conduct a comprehensive survey of the aquatic community in the area of the outfall per the following written specifications:

The permittee shall conduct a comprehensive survey of the aquatic community in the area of the outfall. The survey should be developed to evaluate any effects (long-term) of the discharge on this receiving water over a full season. Sampling should at a minimum include sites within the regulatory mixing zone, outside the mixing zone, and at a reference site. Evaluations at each site should include ***sediment quality****,* ***water quality****, and* ***benthic community*** *components. The potential for contaminant and sediment toxicity shall be evaluated at each site. At a minimum, focus should be on toxic parameters (including metals and any other organic parameters of concern in pulp and paper mill effluents). Other parameters such as nutrients, dissolved oxygen, temperature, and turbidity should also be included. In addition, the area encompassed by the mixing zone as well as areas in close proximity shall be evaluated for the presence of* ***important marine habitats*** *(i.e. nursery/forage areas). These areas shall be documented and evaluated under this study for potential impacts.*

The primary study information objectives (listed above in bold) are each discussed below with recommendations provided for each.

Introduction

The described ocean outfall study plan is at the scope and framework level of detail rather than at the implementation level scale of detail. More advanced planning is necessary prior to implementation which should include, in consultation with appropriate contractors, specific methodologies for each monitoring component. Agreed upon protocols should represent those which have widespread acceptance (e.g. EPA, ODEQ, ASTM, or APHA), that have suitable Quality Assurance/Quality Control procedures, and for which there are adequately characterized and acceptable inter and intralaboratory precision. The described study plan provides for a new data set reflecting the benthic community and physical/chemical conditions in the effluent mixing zone, immediately outside the mixing zone, and at several reference sites, for comparison with the earlier ocean outfall study carried out by CH2M Hill (1986). Figure 1 and 2 provide a map and aerial photo over view of the Nye Beach, Newport, and Yaquina Bay area. The study is based on the concept of a Tiered assessment approach with the initial Tier directed at an assessment of benthic community conditions and whether they are adversely affected by the effluent discharge from the Georgia-Pacific pulp and paper mill. The assessment is based on a comprehensive survey of the benthic community with supportive measurements made of physical and chemical habitat conditions as well as measurements of effluent and water quality.

Monitoring for Tier 1 is proposed for two index periods- one prior to and one following the ocean upwelling associated summer hypoxial period (approximately April and October). Data collected during in the initial period would be analyzed prior to the initiation of the second period. This provides for study streamlining or adjustments to the scope for the second study period based on information/knowledge acquired during the initial phase. Any study plan modifications for the second phase would be subject to ODEQ approval.

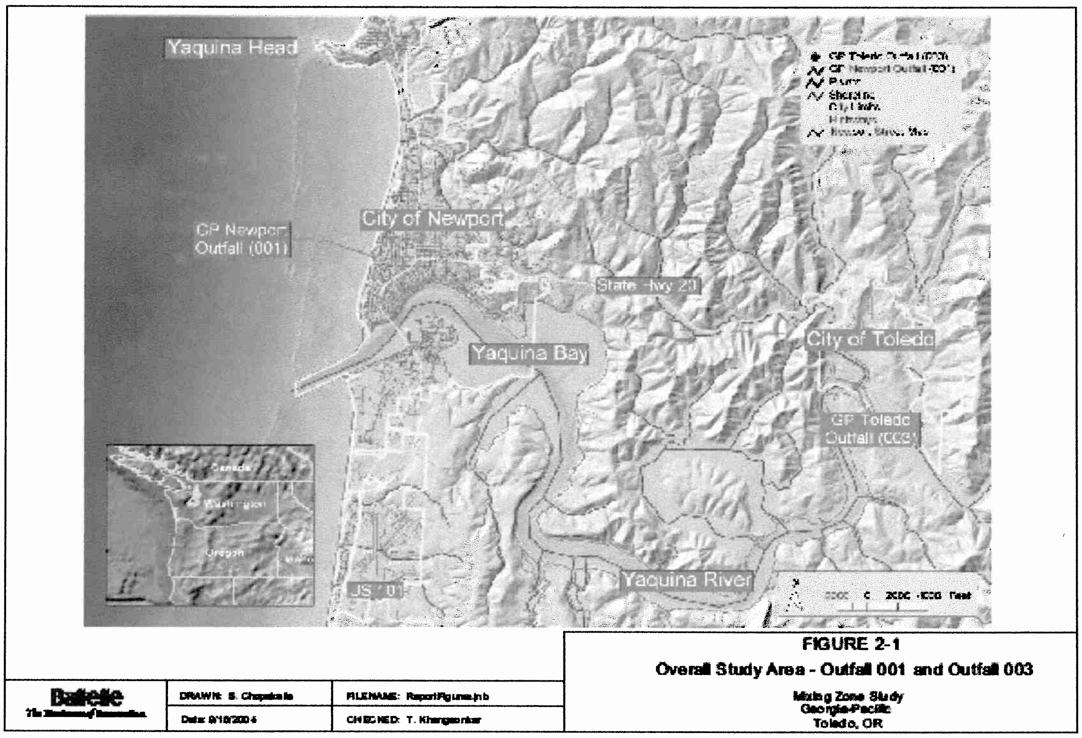

Figure 1. Location of Georgia-Pacific Effluent Outfall and the Adjacent Newport and Yaquina Bay Areas (Khangaonkar et al. 2005).

Tier 1 vs. Tier 2 monitoring

This proposed plan is styled after the Tiered approach advocated by EPA (U.S. EPA 2000a). For this study, *Tier 1* monitoring is designed to characterize the physical, chemical, and biological characteristics of sample sites in areas in and near the effluent mixing zone so they can be compared with those that are in reference areas spatially removed from the effluent discharge. In the event that potentially effluent related ecological differences are identified in *Tier 1* then *Tier 2* studies may be necessary to confirm these findings and to identify any specific responsible effluent related parameters. The two tier approach has been incorporated into several major EPA monitoring programs, including the "Clean Water Action Plan: Coastal Research and Monitoring Strategy" (U.S. EPA et al. 2000a) and the EPA Estuarine and Coastal Marine Waters: Bioassessment Biocriteria Technical Guidance (U.S. EPA 2000b). As established by the federal programs, the focus of *Tier 1* is to develop screening or survey information, based on standardized methods, in order to identify potential benthic community impairment. If *Tier 1* identifies possible impairment additional diagnostic testing (*Tier 2)* may be needed (EPA 2000b). Tier 1 as a screening level assessment is sufficient to identify the presence of impaired conditions, but is not definitive itself with respect to the identification of specific causal stressors. Additional diagnostic levels of the Tiered assessment would be necessary (EPA 2000a) to identify specific mill effluent related stressors as well as to identify the influences of other potential stressors in the Nye Beach area including, 1) the municipal wastewater discharge from the City of Newport, and 2) the discharge from a stormwater creek. EPA provides a Stressor Identification Guidance Document (EPA 2000c) which may also be useful in follow-up efforts to assess which stressor or stressors are the cause of impairment.

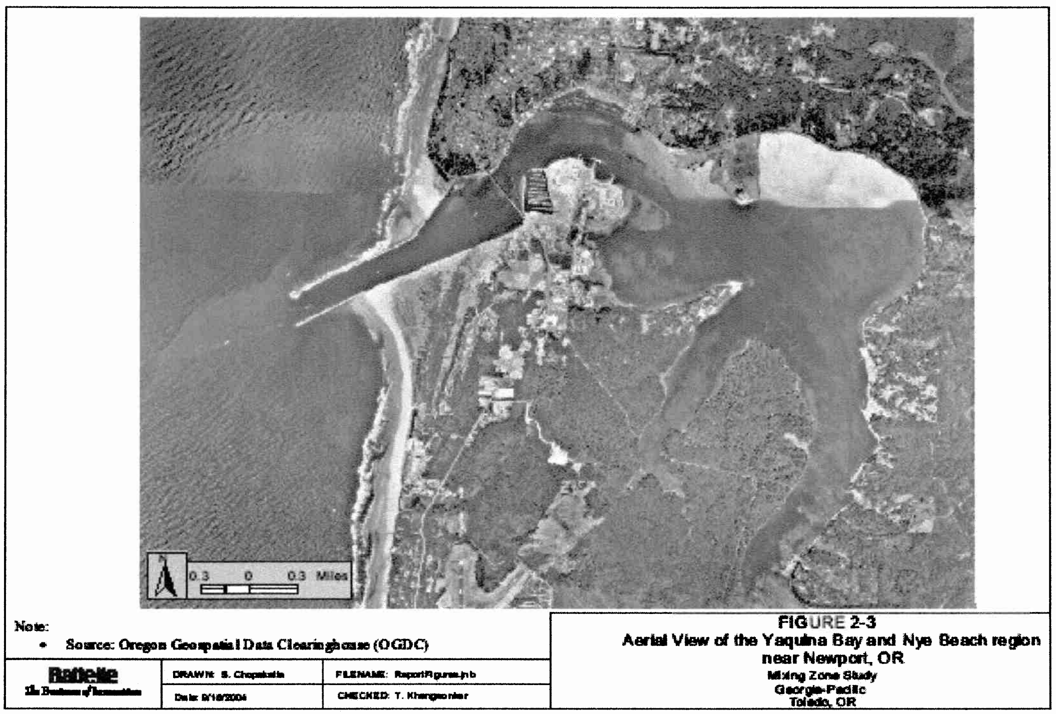

Figure 2. Aerial Photo of Nye Beach and Yaquina Bay Area (Khangaonkar et al. 2005).

Aquatic Community Survey

The primary focus of this *Tier 1* study is to identify whether the benthic community in the area of the Georgia-Pacific outfall differs from nearshore areas with similar habitat but that are spatially removed from the outfall. Although additional physical and chemical measurements will be included in the survey, their primary function will be as interpretive tools in understanding the possible sources of any measured biological differences and in particular whether they are effluent related. Recommended methods for biological sample collection, sample processing, and data interpretation are derived primarily from "Sampling and Analytical Methods of the National Status and Trends Program- National Benthic Surveillance and Mussel Watch Projects" (NOAA 1993), Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicology Analysis Manual (EPA 2001), Estuarine and Coastal Marine Waters: Bioassessment and Technical Guidance (EPA 2000b), Environmental Monitoring and

Assessment Program (EMAP) Laboratory Methods Manual Estuaries (EPA 1995), and a previous Ocean Outfall Evaluation carried out in the area of the Georgia-Pacific Nye Beach outfall (CH2M Hill 1986).

Aquatic community focus- The primary focus of the survey is the benthic community. This focus is based on the sessile nature of benthic organisms, a life style that consequently provides for expressions of long-term exposure to potential environmental stressors, including responses to toxicants or bioaccumulative substances. In addition, benthic organisms typically have shorter life cycles which provide for the expressions of changing environmental conditions as might be reflected in altered reproduction, recruitment, or changes in community characteristics. Fish and larger epibenthic organisms are not included in the survey since their greater mobility and transient nature complicates sampling efforts and would provide for limited conclusions regarding exposure times and expressions of conditions within the Georgia-Pacific mixing zone.

Sample collection- A 0.1 m^2, Van Veen grab sampler (Figure 3) has been the sampler most frequently used in past marine benthos studies and is recommended for this study. A similar surface area Ponar grab sampler has also been used on occasion and is a suitable substitute. The Van Veen sampler is preferred since it would provide consistency with the earlier Ocean Outfall Evaluation carried out by CH2M Hill (1986). EPA (2000b) recommends the use of grab samples rather than core samples for benthic community assessments since most epifaunal and infaunal organisms are present in the upper 10 to 15 cm of deposited sediment where grab samplers are most efficient. Grab samplers (e.g. Van Veen) generally provide for greater sample volumes and consequently greater numbers of benthic organisms which can be used for assessment purposes. The use of alternative sediment devices, including core samplers, may be justified in subsequent assessments if benthic community impairment is detected and it becomes important to understand historical sediment chemical or physical properties as a function of sediment depth.

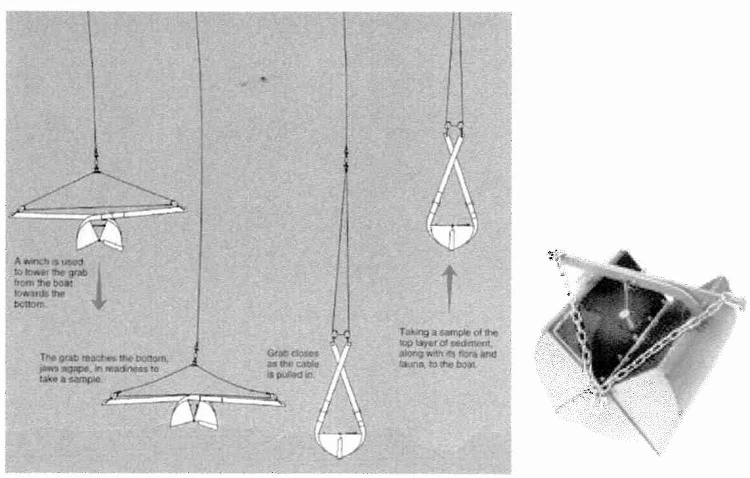

Figure 3. Van Veen Grab Sampler used for Collecting Benthic Organisms and Sediment

Number of samples- The preferred method for determining required sample numbers is one that is based on pre-existing knowledge of sample to sample variability. These data are commonly lacking for field studies and in the absence of these data monitoring programs have generally standardized on from three to five samples for each sample location (EPA 2000b). Five replicate samples were collected for the CH2M Hill (1986) Ocean Outfall Evaluation and for consistency is recommended for this study. In order to interpret variability, it is recommended that three sample sites be selected from within the mixing zone, three sample sites from outside the mixing zone to the south, three sample sites from outside the mixing zone to the north, and from three sample sites from each of three reference locations. For the outside the mixing zone samples, locations should be selected beginning approximately 500 feet north or south of the edge of the effluent mixing zone with each subsequent station an additional 500 feet distant from the previous sample location. Three of the six sample sites located outside of the mixing zone should be within the visible effluent plume to the extent that a visible plume is visible at the time of sampling. Reference sample locations should be selected randomly from within each of the three reference areas. For mixing zone samples, locations should be selected as follows: 1) one sample site 1000 ft to the north of the effluent discharge, 1) one sample site 1000 ft to the south of the effluent discharge, and 3) one sample site located within the visible effluent plume as determined by an aerial survey on the day of sampling. Consequently, for example, three sample sites within the effluent mixing zone would result in a total number of 15 benthic grab samples. Grab samples collected for a given site should be within approximately 100 ft of each other.

Sample processing- Upon collection it is recommended that each grab sample be inspected for the presence of a zone of Redox Potential Discontinuity (RPD). The RPD is indicated by the presence of a change in sediment color from brownish (oxidizing conditions) to gray (reducing conditions). The depth from the sediment surface to the RPD should be recorded for each sample (EPA 2000b). Following RPD depth determination, samples should be 1.0 mm field sieved and preserved with 10% neutral buffered formalin. If the RPD zone is present, the sediment horizon above this zone should be isolated and removed for subsequent sieving and macroinvertebrate analysis. In the absence of an RPD zone the entire sample is processed for benthic macroinvertebrates. This aerobic zone is typically the most biologically productive and consequently provides the most comprehensive and meaningful expression of benthic community characteristics. If practical, field sieving and preservation of the samples is recommended. Samples should be transferred, later, to 70% ethanol in the laboratory (see appropriate protocols for safe handling of formalin and/or ethanol) (EPA 2006a). The use of 1.0 mm vs. 0.5 mm sieves has not been consistent in U.S. monitoring programs. The large sieve has been somewhat more common in marine/estuarine programs and is consistent with the procedures used by CH2M Hill (1986) in the previous Ocean Outfall Evaluation. Organisms present in each grab sample should subsequently be identified to the lowest practicable taxonomic level. EPA (1995) provides guidelines for the types of organisms to be excluded and the levels of taxonomy suitable for some groups of marine benthic infauna (Table 1).

Benthic Community Analysis- Community analysis should be based on community structure and species richness parameters, including: species composition, species richness (the number of taxa/grab sample), diversity (H'), and density (number of individuals/m^2) (EPA 2008). Additionally percent abundance for the top 10 species for each sample from each location should be reported.

Statistical approach and data interpretation- Effluent related differences in the benthic community will be based on the presence of one or more indications of statistically significant differences in community metrics between stations within or near the effluent mixing zone with samples from reference locations spatially removed from the outfall. Part of the interpretation of possible effluent effects will include the extent to which there are significant sample to sample and site to site differences within the reference site locations. Such differences will indicate the presence and extent of natural site to site variability which may interfere with the interpretation of effluent related effects within and near the effluent mixing zone. For this and other reasons additional *Tier 2* testing may be necessary to verify effluent effects and to identify specific causal agents.

Table 1. Guidelines for Organism Identification to the Lowest Practicable Level (EPA 1995)

Faunal groups typically < 1.0 mm that may be excluded-	
Turbellarian flatworms	
Kinorhynchs	
Nematodes	
Harpacticoid copepods	
Cyclopoid copepods	
Ostracods	
Halacarids	
Faunal groups that are clearly pelagic (not benthic) and which may be excluded	
Cladocerans	
Calanoid copepods	
Groups with uncertain to taxonomy (I.D. should be to the lowest practicable level, newer keys may be available to improve taxonomic resolution)	
Phylum Nemertinea	Identify to phylum
Phylum Sipuncula	Identify to phylum
Class Hirudinea	Identify to class
Class Anthozoa	Identify to class
Family Chironomidae	Identify to family

Sediment Quality

Sediment quality assessment for *Tier 1* includes physical as well as chemical parameters of importance in interpreting possible effluent related changes in the benthic community. The need for *Tier 2* studies might, for example, be indicated if sediment metals content near the mill discharge are elevated to levels of concern as indicated by marine chronic water quality criteria established by the EPA (2006b) or Oregon DEQ. These concentrations will also be compared with EPA Marine Sediment Screening Benchmarks (EPA 2008a) which include a consideration for bioaccumulation potential. *Tier 2* testing might necessitate additional sediment samples for chemical testing and/or the initiation of sediment toxicity tests.

Sample collection- See above sample methods for aquatic community survey. The recommended sampler is the same type (Van Veen) used for benthic samples since the primary purpose of *Tier 1* is to characterize the benthic community and its associated habitat. EPA

(2000b) supports the use of grab samples in characterizing benthic community conditions since most infauna and epifauna reside in the upper 10 to 15 cm substrate horizon.

Three grab samples are recommended for each sample location with sampler penetration of ≥ 7 cm. All equipment used in association with sediment sampling and handling should be contaminate free. Sample integrity should be verified by the presence of overlying water and a relatively undisturbed sediment surface layer (Puget Sound Water Quality Action Team 1997). Following verification of sample integrity, the overlying water in the sampler should be carefully removed by siphoning. Each grab sample should then be stored temporarily in a covered contaminate free stainless steel container until all three samples have been collected. Following collection of the last sample, all three grabs should be composited to a single sample (EPA 2000b, EPA 2006 and EPA 2008b). Assurance should be made that this sample is completely mixed prior to further analysis as indicated by the appearance of uniform color and texture. The final composite should be stored in a covered contaminate free stainless steel container under refrigeration until further processing. Appropriate holding times and storage temperatures should be followed for each parameter. The suggested three grab protocol compares to the single grab collected during the CH2M Hill Ocean Outfall Evaluation (1986). Locations for the three grab samples should be within the radius of the area encompassing the benthic grab samples.

Chemical parameters- metals- Measurement of sediment metals concentrations should include those chemicals which have previously been found to occur in the Georgia-Pacific Toledo effluent and for which there are established EPA Priority Pollutant[1], ODEQ[2] chronic marine criteria, or that have been included in the National Mussel Watch monitoring program[3] (Table 2). Mill effluent data are based on priority pollutant scans (Form 2C) carried out in 1996 and 2001, and a more recent scan (Schedule B) carried out in 2006. Of the chemicals recognized by EPA as Potentially Bioaccumulative Toxics (EPA 2008c), only mercury has been measured in the Georgia-Pacific effluent at reporting thresholds. Tin, although it is not known to occur in the mill's effluent, is also recommended for inclusion as a possible marker for Yaquina Bay influences since it is a common component of anti-fouling boat bottom paint. The sample devises, sample containers and sample handling shall be carried out with appropriate safeguards to avoid sample contamination or other factors which might influence the accurate determination of sample chemical concentrations.

Chemical parameters- other- Total organic carbon and total volatile solids are included as additional sediment parameters as they may provide useful information regarding the sediment organic content (EPA 2000b).

Physical parameters- The proposed list of sediment physical parameters (Table 2) represent a consensus suitable for a *Tier 1* assessment based on approaches used by EPA 1993, EPA 2000b, EPA 2006, NOAA 1993, and CH2M Hill 1986. Sediment grain characteristics should be carried out according to the methods of Folk and Ward (1957) which are based on sieving and the determination of mean particle size, sorting characteristics, kurtosis, and skewedness. Similar procedures were followed in the previous Ocean Outfall Evaluation (1986 CH2M Hill). Sediment silt-clay content and moisture content should also be determined.

Statistical approach and data interpretation- The presence of differences in sediment physical or chemical conditions will be based on statistical analysis using appropriate parametric or non-parametric procedures. As noted previously, the interpretation of the presence of significant site-to-site differences will require an assessment of the extent to which this occurs and a determination of whether the differences are related to natural variability as measured at the reference locations. The presence of significant physical habitat differences in or near the effluent mixing zone will not in itself lead to inferences about effluent related effects unless they are accompanied by corresponding effluent related chemical increases and are associated with measurable differences in the benthic community.

Table 2. Suggested Parameters for Aquatic Community Survey - Sediment Analysis

Chemical parameters		
	Metals	Arsenic [1]
		Cadmium [1, 2, 3]
		Chromium [1, 3]
		Copper [1, 2, 3]
		Cyanide [1, 2, 3]
		Lead [1, 2, 3]
		Mercury [1, 2, 3]
		Nickel [1, 2, 3]
		Selenium [1, 3]
		Silver [1, 2, 3]
		Zinc [1, 2, 3]
		Tin (total)
	Total phenols	
	Total organic carbon	
	Total volatile solids	
Physical parameters		
	Mean particle size	
	Sorting characteristics	
	Kurtosis	
	Skewedness	
	Silt-clay content- percent	
	Moisture content- percent	

Water Quality

It should be noted at the outset that the interpretation of water quality data from the near shore marine environment is difficult due to the large amount of variability associated with tidal, wind, upwelling, and adjacent estuarine influences. The NOAA Mussel Watch and National Benthic Surveillance, for example, states that "while seawater represents the primary medium for transport of pollutants and transfer of pollutants to the biota, and while most of the existing marine toxicological data relates to levels of aqueous phase pollutants (i.e. water quality criteria), actual pollutant levels in seawater are highly variable due to the sporadic effects of runoff from storms, dumping events, etc. Most water column pollutant measurements in estuaries or coastal waters represent snapshots of data. Therefore, this variability coupled to the fact that pollutant levels may be quite low in the samples, leads to the recommendation that direct analysis of seawater for pollutant levels not be included in the Status and Trends Program" (NOAA 1993). With this caveat, the parameters listed below provide for a characterization of core parameters consistent with the goals of a *Tier 1* investigation

Continuous vertical profiles- Datasonde capabilities (Figure 4) should be considered for obtaining continuous vertical profiles. This may be especially useful in characterizing water column conditions that might be influenced by stratification due to the differing densities of effluent and seawater. Common datasonde sensors that are recommended for the monitoring program include conductivity, depth, dissolved oxygen (DO), pH, temperature and transmissivity (EPA 2008) (Table 3).

Appropriate calibration for each sensor should be carried out at each datasonde station deployment in accordance with manufacturer's recommendations and procedures acceptable according to EPA or APHA (2001) protocols. The continuous vertical profiles should be taken at a single location within a radius encompassing the array of 5 benthic samples at each of monitoring sites. These continuous profile data replace some measurements previously carried out at discrete depths in the Ocean Outfall Evaluation (CH2M Hill 1986).

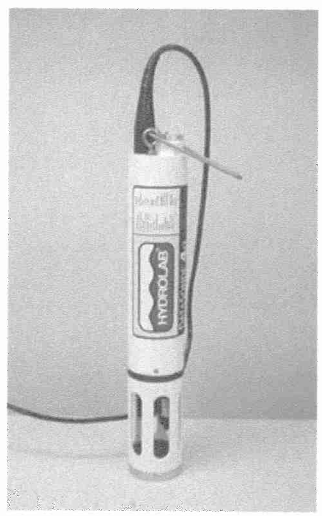

Figure 4. Example of a Datasonde used for Continuous Vertical Profile Samples

Discrete depth water samples- It is recommended that sampling focus on three discrete depths at 0.5 m beneath the surface, at mid-depth, and at 0.5 m above the bottom (EPA 2006 and EPA 2008). The near bottom sample should be taken following a 3 min delay to avoid sampling bottom material that may have been disturbed by the sampler. For this study, based on locations sampled by CH2M Hill (1986) the sample depths would most likely be ~ 0.5 m, 5.5m, and 10.5 m depth. In the CH2M Hill (1986) Ocean Outfall Evaluation discrete samples were collected for many (but not all) parameters at each 2 m depth. The sample design proposed here includes fewer depths but more parameters and combined with the vertical profile information should provide adequate information to address *Tier 1* assessment for possible biological impairment and preliminary information respect to causality. Discrete water samples would be collected via a Kemmerer, Van Dorn or equivalent sample device with samples taken within a 50 m radius of the array of benthic sample sites.

Suggested parameters for monitoring are provided in Table 3. Appropriate precautions should be taken to avoid sample contamination during sampling and subsequent sample handling according to established Good Laboratory Practices. Specific analytical procedures should be in accordance with established EPA, APHA (2001) methods. Alternative methods or methods better adapted to seawater analysis are acceptable (preferable) providing they have been recognized acceptable by regulatory authorities, have suitable QA/QC procedures, and acceptable precision data. The majority of the selected water quality parameters below represent a consensus based on previous monitoring by CH2M Hill[1] (1986), EPA[2] (2000b, 2001, 2006, and 2008) and NOAA[3] (1993). The same metals assessed under "sediment" are also included in the water column analysis. Also suggested for samples within the effluent mixing zone is BOD_5 providing sample holding time requirements can be met and that initial measurements indicate that BOD_5 is at a measurable concentration.

Color as well as total resin and fatty acids are added as additional parameters due to the possibility they may serve as markers for the presence of effluent from the pulp and paper mill. It should be noted, however, that the later two parameters are also natural expressions of the break down of forest materials and that their presence in the nearshore marine environment may also be due to contributions from the Yaquina River and its forested watershed. Resin/fatty acid analysis is costly. In order to avoid unnecessary expense one mid-depth sample will be analyzed from each of the three reference sites (three samples total), and from the mid-depth sample for the three mixing zone sites (three samples total) and six outside mixing zone sample locations (total of 12 samples) to determine if these compounds are present in measurable concentrations. In the event that resin/fatty acids are found to be present in measurable concentrations the remaining samples for all locations will be analyzed. Methods for the analysis of resin/fatty acids should follow NCASI (1986), which includes procedures for sample preservation and specifications for storage time limits. Storage time specifications will require that initial screening samples be analyzed promptly in order for the analysis of follow-up samples to take place within the recommended storage time limits.

Measurements should also be made of photosynthetically active radiation (P.A.R.) at each of the three depths. Measurements should be made with the sensor oriented toward the surface and with the reading integrated over a minimum period of 10 sec. Shading from the sensor tether, vessel, or sampling personnel must be avoided. In addition to underwater measurements an additional measurement should be made with the sensor dried and pointed skyward in the open air immediately above the water surface. The time of day and sky conditions should also be measured and recorded in conjunction with each P.A.R. measurement.

There have been recent studies and literature reviews where potential endocrine disruption (ED) effects on fish from pulp and paper mill effluent have been investigated or reported. No studies to date have implicated pulp and paper mill effluent related ED compounds with reductions in fish populations although there have been indications of reduced gonad size and fecundity (Hewitt et al. 2008). Full life-cycle fish studies with a variety of U.S. pulp and paper mill effluents have confirmed the reduction in fecundity but only after effluent concentrations reach between 8 and 100% effluent (Borton et al. 2009). By way of contrast, field dye study measurements made immediately above an outfall diffuser port (i.e. with little mixing) have indicated a maximum effluent concentration of 2.1% (1:47 dilution) at the Georgia-Pacific outfall (Khangaonkar et al. 2005) with a further reduction to 0.6% (1:175 dilution) effluent at the edge of the mixing zone (ODEQ 2006). Indications to date, with respect to ED compounds, are that the responsible agents are natural components of trees and other vegetation known as phytosterols rather than materials used or produced in the pulp and paper process. The lack of specific chemical dose-response information, the lack of evidence for population level effects, and the likelihood that phytosterols are rather ubiquitous in the environment (especially adjacent to a forested watershed) are causes to exclude these substances from the *Tier 1* survey.

Table 3. Suggested Water Quality Parameters for the Aquatic Community Survey

Continuous vertical profile- datasonde		
	Conductivity	
	Depth	
	Dissolved oxygen	
	pH	
	Temperature	
Discrete depth and composite samples		
	BOD_5 (mixing zone only)	
	Color	
	Density/salinity [1,2]	
	Depth[1,2]	
	Dissolved inorganic nitrogen (nitrite + nitrate + ammonia) [2]	
	Metals	
		Arsenic
		Cadmium
		Chromium
		Copper
		Cyanide
		Lead
		Mercury
		Nickel
		Selenium
		Silver
		Zinc
		Tin (total)
	Total phenols	
	Orthophosphate [2]	
	P.A.R.	
	pH[1,2]	
	Resin/Fatty acids[1]	
	Total suspended solids	
	Turbidity[2]	

Additional composite water quality samples- The collection of composite samples for chemical analysis is also suggested for effluent from the Georgia-Pacific mill, the Newport wastewater treatment plant, and the Nye Beach stormwater creek during the period of sample collection. This analysis should include the same list of parameters assessed for the discrete depth water samples (Table 3).

Statistical approach and data interpretation- Similar to sediment analysis, water column measurements are made in support of the benthic community assessment. Differences in water column chemistry and other characteristics will be based on the application of appropriate statistical procedures with measurements made at the reference locations serving as a tool to address the extent of natural variability in parameters at locations removed from the effluent mixing zone. Water quality differences in or near the effluent mixing zone will not in themselves be considered an indication of an effluent impact unless they are accompanied by measurable differences in one or more of the benthic community characteristics.

Important Marine Habitat

A previous study of the outfall included environmental mapping to address the physical and biological attributes of the area (Khangaonkar 2005). Included was the identification of any unique habitat for benthic organisms, shellfish, or fish. Although the study concluded that there was an absence of critical or unique habitat in the area of the outfall and mixing zone, there were qualifiers. One primary qualifier was, due to the absence of detailed local studies, that the study was not carried out at a scale sufficient to detect smaller scale possibly important habitat features.

The recommended approach for this study is based on the acquisition of new habitat information for the study area and then the use of available data sources, such as the PaCOOs: West Coast Habitat Portal (http://pacoos.coas.oregonstate.edu/MarineHabitatViewer/viewer.aspx) or the Oregon Nearshore Strategy (Oregon Department of Fish and Wildlife 2006) as possible interpretive lenses for judging potentially important or sensitive species or species related habitat that occur in the effluent mixing zone or areas immediately outside the mixing zone.

Available technologies for identifying and mapping unique habitat features include diver surveys, Remotely Operated Vehicles (ROVs), multi-beam SONAR, side-scan SONAR, or a combination of still or video cameras operated by diver or towed by sled. Although boat towed video or SONAR are the most obvious choice for this habitat survey the specific assessment method will depend on sea surface and water conditions at the time of the survey.

The recommended survey procedure is based on a grid within the 1,000 by 2,300 ft mixing zone represented by transects running parallel to the shoreline and spaced 40 feet (+/- 10 feet) apart. The survey area should also include an extension 1,500 feet to the north and south of the mixing zone so as to include the three corresponding "outside the mixing zone" biological sample stations. The mill NPDES permit and ODEQ should be consulted with respect to the exact location and dimensions of the effluent mixing zone. A smaller Zone of Initial Dilution (ZID) occurs within 45 ft of the discharge. This area may be included in the survey as well but a notation should be made that any reported features were in or near the ZID. This pattern would, consequently, represent video or SONAR records for 25 individual north to south or south to north transits within the mixing zone. Effluent mixing zone limits and transect track lines would be established and run via digital GPS. A track log of each transect should be recorded from the GPS and cross-referenced with the resulting video or SONAR record. In addition to the mixing zone and outside the mixing zone surveys, surveys should also be carried out at the three reference sample locations. This effort allows a determination of whether there are any obvious habitat differences between the reference locations or between reference locations and the mixing zone and outside the mixing zone sample locations. The reference zone habitat surveys are for general reference only and can be abbreviated over those in the mixing zone and outside the mixing zone surveys. Two transects extending across the approximate diameter of a circle encompassing the five benthic sample sites are recommended.

The habitat survey should take place at the same time as other monitoring parameters. Following the habitat survey the video or SONAR records should be reviewed for any unique habitat features within the mixing zone. These features may include the presence of rock outcroppings or other submerged objects or macrophyte beds that may serve as refuge or habitat for marine organisms.

Habitat observations should include:

> Submerged objects- rocks, wrecks, other physical habitat
> Substrate- pockets or outcrops of bedrock, gravel, mudstone, soft sediment, other

The significance of unique marine habitat in the mixing zone may require further survey to verify whether these features were in fact unique or important. Such follow-up survey may require consultation with the literature or resources such as the Oregon Nearshore Strategy (Oregon Department of Fish and Wildlife 2006) to identify the habitat requirements of special species and/or a determination of whether these habitats also occurred in other areas, including the reference areas used in this study.

Statistical Design Overview and Data Treatment

As acknowledged previously, statistical treatment of data may be limited due to a lack of advanced information with respect to measurement error, including the extent of natural temporal and spatial variability. This is not unusual for field studies and many monitoring programs do not estimate the power of the sampling design due to a lack of this information (EPA 2001). One benefit of *Tier 1* monitoring is that data will be generated to help address measurement error which can in turn be useful if future *Tier 2* studies are warranted. Appropriate parametric or non-parametric statistical procedures will be used in determining whether there are significant differences in biological or physical/conditions between sample locations, and in particular whether there are differences between the stations within the mixing zone or just outside the mixing zone and the reference stations further afield. The use of multi-dimensional scaling or other similar statistical approaches is also encouraged as a tool in relating a given set of habitat (water quality and sediment) conditions with biological conditions and in identifying any corresponding key driving parameters.

Sample Design Overview

The proposal is for two sample periods one prior to and one following the expected low dissolved oxygen summer "hypoxial" period. Table 4 provides a summary of the types, parameters, locations, and numbers for the various elements for the initial monitoring period. It is expected that some change in scope or other adjustments may take place for the second sampling period following the analysis of data and knowledge gained from the initial sampling.

Location and Types of Sample Sites- The ODEQ description of study objectives includes that sampling be carried out within the effluent mixing zone, outside the effluent mixing zone, and at a reference site. In addition to these general sample area descriptors it is also important to recognize that benthic aquatic communities are very much influenced by their physical habitat and consequently it is imperative that all three sample area categories be as similar to each other as possible with respect to non-anthropogenic habitat features, including bottom type and depth.

The within mixing zone sample location should be within the regulatory established mixing zone described in the mills NPDES permit. This zone encompasses an area approximately 1,000 ft x 2,300 ft with the longest dimension running parallel to the shoreline. For the mixing zone, the three sample locations should be selected as follows: 1) one sample site 1000 ft to the north of the effluent discharge, 1) one sample site 1000 ft to the south of the effluent discharge, and 3) one sample site located within the visible effluent plume as determined by an aerial survey on the day of sampling. *Sampling for the combined mixing zone sample locations would represent 15 benthic samples (5/location), 3 sediment samples (composited from 9 individual grabs) and 3 sets of water quality samples or profiles.*

The outside the mixing zone sample sites should be collected adjacent to the spatial limits of the mixing zone at a depth within +/- 0.5 m of the range of depth of the mixing zone samples, based on a Mean Lower Low Water tidal datum. Three locations should be selected for sampling in the area adjacent to the mixing zone extending north and three locations in the area adjacent to the mixing zone extending south. The three stations should be spatially distributed so that the first is approximately 500 feet (north or south) from the edge of the mixing zone with the remaining samples each extending an additional 500 feet (north or south). Additionally, three of the six sample locations should, to the extent possible based at the time of sampling, be within the visible effluent plume. The above are provided as guidelines. The primary important feature, again, is that natural habitat features be as similar as possible to natural habitat features in the mixing zone and reference areas. To accomplish this, if necessary, samples may be located in closer proximity to each other or closer to the edge of the mixing zone. *Sampling at each of the six outside the mixing zone location consists of a total of 30 benthic grab samples, 6 sediment samples (composited from 18 individual grab samples), and 6 sets of water column samples or profiles.*

Table 4. Summary of Sample Parameters, Approaches, Locations and Sample Numbers for the Proposed Georgia-Pacific Outfall Aquatic Community Survey

	Parameters	Sample approach	Sample locations	Samples	Total samples
Aquatic community survey	Benthic community structure/species richness	Van Veen sampler	18 (3 within mixing zone, 6 outside zone, and 9 reference locations)	5 grabs each location	90
Sediment quality	Chemical/physical properties	Van Veen sampler	18 (see above)	1 (3 grabs each location-composited)	18
Water quality-continuous vertical profile	Conductivity, depth, DO, pH, temperature	Datasonde	18 (see above)	1 profile each location	18
Water quality-discrete depth	BOD, color, salinity, depth, metals, nutrients, pH, resin/fatty acids, TSS, turbidity, P.A.R.	Grab sample	18 (see above)	3 depths each location	54
Water quality-composite samples	See parameters above	Composite sampler	3 (G-P and Newport WWTP effluent + Nye Beach stormwater creek	1	3
Important habitat	Any unique habitat features	Video camera or SONAR	Mixing zone + 1500 ft north and south	Transits spaced 40 ft apart	25- 5,300 ft transits

Three reference areas are recommended. With respect to "reference locations," it should be noted that the term and concept of "reference" areas is not without controversy. For example, EPA (2000b) cautions that although reference sites are intended to establish non-impairment conditions that "In, fact, it can be argued that no unimpaired sites exist" due to land use practices, urban areas, and other disturbances (EPA 2000b). Consequently, reference conditions require careful selection and at minimum require the recognition and identification of the possible influences of other point or not-point source influences and, at a minimum, that physical habitat conditions are as similar as possible. The previous Ocean Outfall Evaluation (CH2M Hill 1986) found it necessary to locate reference stations no closer than 8,000 meters north and 4,000 meters south of the effluent outfall in order to approximate physical habitat conditions in the area of the discharge. One of the features that made reference site selection difficult was the need to identify candidate sites with an offshore mudstone reef as extensive as the one located in the area of the effluent outfall. If alternative closer candidate reference locations can not be located it is recommended that the two CH2M Hill reference sites be re-sampled for this aquatic community survey. Three sample locations should be selected randomly within each reference area. These locations should represent sample depth +/- 0.5 m of the range of sample depths for the mixing zone samples. *A set of three reference sites would represent a total of 45 benthic grab samples, 9 sediment grab samples (composited from 18 individual grabs) and a set of 9 water column samples or profiles.*

It is also recommended that three composite samples be collected during the period of the study representing: 1) treated Georgia-Pacific effluent, 2) treated effluent from the Newport wastewater treatment plant, and 3) water from the Nye Beach stormwater creek (if flow is present). Locations for these samplers should be such that they allow for suitable access to power and security while still providing for effluent of similar quality as discharged to the ocean.

The locations of all sample sites and individual grab or water samples should be recorded via Digital GPS with an expected accuracy of better than +/- 1 m.

Sample Timing

Tier 1 studies are often limited to a single Index Period (EPA 2000b) which requires a decision as to the proper time of year for sampling. This decision may be based on the time of the year representing worst case conditions in terms of effluent discharges (i.e. highest concentration), the time of the year the biological community is most stable and consequently most accurately assessed (i.e. summer), or a time of the year when a community is particularly vulnerable (e.g. spawning season for a particularly important species). Although summer is often the time selected as an Index period for assessing benthic community conditions it is suggested for this study that this period be avoided due to the likely occurrence of hypoxial conditions associated with coastal upwelling. Extremely low dissolved oxygen may over ride other environmental factors (both natural and anthropogenic) and prevent the detection of conditions related to the pulp and paper mill effluent discharge. The proposal here is for two sample periods (April/May and September/October) that bracket the expected hypoxial period of mid-summer. A more specific determination of sample timing will be made based on the availability of oceanographic data and a determination of the timing and extent of seasonal hypoxia for the summer season associated with the study.

Quality Assurance/Quality Control

Following study plan acceptance but prior to study initiation a detailed QA/QC plan will be submitted to the ODEQ for approval. The plan will include details such as blank and duplicate collection, equipment decontamination procedures, sampling protocols, methods detection/quantification targets, etc.

Overview

The intent of the study proposal presented here is to accomplish the aquatic community survey described by ODEQ in a request to Georgia-Pacific, Toledo. The proposal represents a "strawman" in that a study encompassing such a broad range of biological, chemical, and physical parameters, and that takes place in the very challenging nearshore marine environment will benefit from the input of others with related expertise. The proposal outlines a set of parameters which includes the collection of a total of 90 samples for benthic community assessment, 18 composited sediment samples for physical and chemical analysis, and 18 sets of data representing water quality grab and continuous depth profiles. These data would be generated, per the ODEQ request, from areas within the effluent mixing zone, from areas immediately adjacent to the mixing zone and from three nearby reference areas. Two monitoring periods are included, one taking place prior to the expected summer hypoxial period and the other following. Data analyzed from the first monitoring period should be analyzed prior to initiation of the second monitoring period so that knowledge/information gathered during the initial period can be used to streamline or adjust the scope prior to the second sampling period.

The study proposal outlined here is based largely on EPA (2000b) and other federal monitoring programs as well as an earlier Ocean Outfall Evaluation (CH2M Hill 1986) and is intended to provide a comprehensive initial environmental overview in the area of the Georgia-Pacific outfall that could then provide the basis for future evaluations if effluent related effects are suggested. This tiered approach has been advocated by EPA and the study design presented here represents what is considered as *Tier 1*. This level of assessment should be suitable to identify the presence of effluent related biological impairment and, if present, to provide an initial indication of possible causes.

The proposal represents a Scope and Framework level of study design. Additional detail will be necessary with respect to developing and implementing specific protocols for each study parameter. With any field study it should also be assumed that "Adaptive Management" will be recognized as an essential element of a successful study and that some changes in sample design and conduct may be necessary and appropriate once the monitoring program is underway.

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