Visual Impact
and
Ecological Concerns Assessment
for the
Totten Inlet Mussel Rafts Project

Prepared by:
EDAW, Inc.

in association with:
Evans-Hamilton, Inc.
and
Richard Dame, Ph.D.

Taylor Resources, Inc.
S.E. 130 Lynch Road
Shelton, Washington 98584

January 1998
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# Table of Contents

**Table of Contents**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>i</td>
</tr>
<tr>
<td><strong>1.0 Introduction</strong></td>
<td>1</td>
</tr>
<tr>
<td>1.1 Purpose of Report</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Project Overview</td>
<td>1</td>
</tr>
<tr>
<td><strong>2.0 Visual Impact Assessment</strong></td>
<td>11</td>
</tr>
<tr>
<td>2.1 Impact Assessment Overview</td>
<td>11</td>
</tr>
<tr>
<td>2.1.1 Landscape Setting</td>
<td>11</td>
</tr>
<tr>
<td>2.1.2 The Viewer</td>
<td>11</td>
</tr>
<tr>
<td>2.1.3 Facility Siting and Design</td>
<td>12</td>
</tr>
<tr>
<td>2.1.4 Visual Assessment</td>
<td>12</td>
</tr>
<tr>
<td>2.2 Gallagher Cove Inventory and Analysis</td>
<td>13</td>
</tr>
<tr>
<td>2.2.1 Landscape Setting</td>
<td>13</td>
</tr>
<tr>
<td>2.2.2 The Viewer</td>
<td>14</td>
</tr>
<tr>
<td>2.2.3 Facility Siting and Design</td>
<td>15</td>
</tr>
<tr>
<td>2.2.4 Visual Assessment</td>
<td>16</td>
</tr>
<tr>
<td>2.3 North Totten Inventory and Analysis</td>
<td>19</td>
</tr>
<tr>
<td>2.3.1 Landscape Setting</td>
<td>19</td>
</tr>
<tr>
<td>2.3.2 The Viewer</td>
<td>21</td>
</tr>
<tr>
<td>2.3.3 Facility Siting and Design</td>
<td>23</td>
</tr>
<tr>
<td>2.3.4 Visual Assessment</td>
<td>23</td>
</tr>
<tr>
<td><strong>3.0 Ecological Concerns Assessment</strong></td>
<td>30</td>
</tr>
<tr>
<td>3.1 Tidal Flushing</td>
<td>30</td>
</tr>
<tr>
<td>3.2 Carrying Capacity</td>
<td>33</td>
</tr>
<tr>
<td>3.3 Waste Production</td>
<td>34</td>
</tr>
<tr>
<td>3.4 Bivalves As Ecosystem Stabilizers</td>
<td>37</td>
</tr>
<tr>
<td>3.5 Recommendations / Mitigation Measures</td>
<td>38</td>
</tr>
<tr>
<td><strong>4.0 Cumulative Impact Analysis</strong></td>
<td>39</td>
</tr>
<tr>
<td>4.1 Marine Ecology</td>
<td>39</td>
</tr>
<tr>
<td>4.2 Upland Land Use</td>
<td>39</td>
</tr>
<tr>
<td>4.3 Navigation</td>
<td>40</td>
</tr>
<tr>
<td>4.4 Visual Resources</td>
<td>40</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS (cont.)

4.5 Access.............................................................................................................. 41

References............................................................................................................. 42

Appendices

Appendix A. State of Washington, Aquaculture Siting Study (pages 61-86)

List of Tables

Table 3.1 Previous Estimates of Flushing in Puget Sound Ordered from Shortest
(Port Ludlow) to Longest (Dabob Bay)................................................................. 31
Table 3.2 Volumes of Totten Inlet......................................................................... 32
Table 3.3 Present and Proposed Bivalve Biomass in Totten Inlet with Pumping and
Clearance Times.................................................................................................. 35
Table 3.4 Drogue speeds (6 meter depth) at Approximately Mid Channel in Totten
Inlet During 23-28 April 1975........................................................................... 37
Table 3.5 Tabular Histogram of Current Speeds at the North Totten Site.......... 37

List of Figures

Figure 1.1 Project Location Map.......................................................................... 2
Figure 1.2 Proposed Project Map.......................................................................... 3
Figure 1.3 Gallagher Cove Site ............................................................................ 4
Figure 1.4 North Totten Site.................................................................................. 7
Figure 1.5 Typical Mussel Raft “Unit”................................................................. 8
Figure 1.6 Typical Two-raft Cross-section............................................................ 9
Figure 1.7 Cross-section of Mussel Rafts at Gallagher Cove............................... 10
Figure 2.1 Visual Assessment Methodology......................................................... 13
Figure 2.2 Key Observation Points...................................................................... 17
Figure 3.1 Bivalve Clearance Time and Water Mass Residence Time Among Major
Producing Systems............................................................................................ 36

List of Photos

Photo 1 Existing View of Gallagher Cove Mussel Rafts Site............................ 14
<table>
<thead>
<tr>
<th>Photo</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Existing View at Low Tide of North Totten Mussel Rafts Site</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Existing View at High Tide of North Totten Mussel Rafts Site</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Panorama of Existing View -- North Totten Site at Low Tide</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>Panorama of Existing View -- North Totten Site at High Tide</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>Existing Conditions at Low Tide</td>
<td>28</td>
</tr>
<tr>
<td>7</td>
<td>Future Conditions at Low Tide with Proposed Mussel Rafts</td>
<td>28</td>
</tr>
<tr>
<td>8</td>
<td>Existing Conditions at High Tide</td>
<td>29</td>
</tr>
<tr>
<td>9</td>
<td>Future Conditions at High Tide with Proposed Mussel Rafts</td>
<td>29</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION
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1.1 Purpose of Report

Taylor Resources, Inc. (Taylor) prepared a State Environmental Policy Act (SEPA) environmental checklist (WAC 197-11-315) and submitted it to Thurston County (County) for Taylor’s proposed Totten Inlet mussel raft project (Project) in October 1996. After reviewing the environmental checklist, the County requested that Taylor undertake further analysis of potential Project impacts in order to provide decision-makers with additional information (WAC 197-11-335) deemed necessary for the County’s threshold determination process (WAC 197-11-330). In particular, the County, due in part at the request of the Association for the Protection of Hammersley, Eld and Totten Inlets (APHETI), requested that further assessment of the Project be undertaken to address the Project’s potential impacts related to: (1) the area’s visual resources; and (2) specific ecological concerns, i.e., tidal flushing, carrying capacity, and waste production, associated with the Totten Inlet ecosystem.

The purpose of this report is to provide the County with the additional information required to complete their threshold determination process. It is separated into five main parts: (1) this introductory chapter; (2) a visual impact assessment overview, and an assessment of both of the Totten Inlet sites considered under the proposed project, (3) a discussion and analysis of the Project and its relationship to the following ecological elements raised in the APHETI Report: tidal flushing, carrying capacity, and waste production; (4) a discussion related to cumulative impacts; and (5) recommendations and mitigation measures.

1.2 Project Overview

Taylor currently operates 21 mussel rafts in a two acre site at the mouth of Gallagher Cove in Totten Inlet, Thurston County (Figure 1.1). These rafts are currently configured as seven 3-unit rafts structures (i.e., three rafts per unit) and cover a total water surface area of about a half acre.

As shown in Figure 1.2 Taylor is proposing the surface installation of additional raft structures at the Gallagher Cove site and at a new site approximately one mile northward; the North Totten site. The rafts are proposed for the purpose of holding ropes on which blue mussels (Mytilis edulis galloprovincialis) and/or other shellfish would be seeded, grown, and harvested. The amount of rafts at the Gallagher Cove site would be doubled from its current configuration of seven 3-unit raft structures to seven 6-unit raft structures; adding 21 additional rafts to the site for a total of 42 rafts (Figure 1.3). The Gallagher Cove site would continue to be situated at approximately 16 feet of water, measured at mean low water (MLW).
Source: USGS, Squaxin Island Quadrangle

Figure 1.1 Project Location Map
Source: Taylor Resources, Inc.

Figure 1.2 Proposed Project Map

Legend
- Existing raft site
- Proposed raft site

Not to Scale
Figure 1.3  Gallagher Cove Site
There are currently no mussel rafts located or being operated at the North Totten site. The North Totten site would consist of six 7-unit raft structures and two 8-unit raft structures, for a total of 58, 30 foot by 34 foot rafts. As shown in Figure 1.4, the rafts would be situated about 600 feet from the shoreline and occupy an overall area approximately 700 feet by 650 feet (10.45 acres). The tidal elevation varies at the North Totten site from 16 feet to 70 feet at MLW. As shown in Figure 1.5, a typical raft structure would be 30 feet by 34 feet and linked together with other raft structures to form a raft unit.

All of the rafts would be constructed of natural, untreated lumber and would rise approximately one to two feet above the water surface depending on production levels. Typically, recycled 50 gallon plastic barrels would be used as flotation devices for the rafts. As shown in Figure 1.6, each raft structure would be secured in place at both ends with nylon rope and concrete wedge anchors. The rafts would have a varied number of synthetic ropes hanging 10 to 20 feet into the water column. The ropes would provide the habitat needed for the mussels to survive and would not be allowed to touch the seafloor in order to protect them from predation. For additional protection from predators such as diving ducks and perch each raft would be enclosed with a net for most of the crop cycle. Lighting would be installed on the rafts according to U. S. Coast Guard standards and guidelines as navigational aids.

Due to the relatively shallow depth at the Gallagher Cove site and the need to keep the lines from dragging on the bay floor, the raft structures at this location have been designed with a plastic-coated galvanized steel mesh that would be suspended by nylon ropes from each raft structure to at least 10 inches above the bay floor at all times (Figure 1.7). Adjustments would be possible by lengthening or shortening the suspension ropes.

In recognition that the proposed Project would play a roll in the overall ecology of the Totten Inlet, the following measures would be undertaken to monitor for potential ecological impacts:

1. Phase in the expansion of the Gallagher Cove area over a one to two year time period, and the North Totten farm over two to four years.

2. Take weekly Secchi readings and monitor dissolved oxygen at a location within the Gallagher Cove farm, the North Totten farm, and a third (baseline) site in Totten Inlet, independent of these two areas.

3. Dive under the farms periodically to remove unnatural debris that inadvertently may be dropped during the course of work.
4. Contract with a independent third party contractor to perform a semi-annual benthic survey to assess:
   - changes in the benthic community underneath the mussel rafts;
   - sedimentation; and
   - unnatural farm debris (gloves, netting, etc.) that has not been cleaned up in routine diving under the farms.

5. Monitor the growth rate and meat yield in adjacent clam and oyster crops. The goal being to reduce the summer mortality problem in oysters while maintaining adequate food for all filter feeding resources in the Inlet. If it appears at anytime that there was a reduced growth rate or meat condition, production would be modified and/or shifted to other areas within the Puget Sound.

6. Monitoring at the raft sites shall be conducted for an initial period of five years. At the end of this five year time period a performance assessment shall be undertaken to determine the need for continued monitoring in the future.
Source: Taylor Resources, Inc.

Figure 1.4  North Totten Site
Source: Taylor Resources, Inc.

Figure 1.6 Typical Two-raft Cross-section
Plastic-coated galvanized steel mesh will be suspended by nylon rope from raft to at least 10' above sea bottom at all times. The dimensions of the bottom are 30' x 34' of 1.25" mesh. Adjustments can be made by lengthening or shortening the suspension ropes.

Plastic floatation bobbers are 10" diameter. Bobbers will be placed approximately every 4' apart on the four sides of each raft.

Ground impact will not exceed 20% of project area.

Source: Taylor Resources, Inc.

Figure 1.7  Cross-section of Mussel Rafts at Gallagher Cove
2.0 Visual Impact Assessment
2.0 Visual Impact Assessment

2.1 Impact Assessment Overview

This visual impact assessment uses the inventory and evaluation process presented in the State of Washington Department of Ecology (Ecology) Aquaculture Siting Study (Study) prepared in October 1986 (Ecology, 1986). Key elements of the Study are summarized below and the Study’s Visual Impact Assessment section is provided in Appendix A.

In general, the degree of visual impact from aquaculture facilities is highly variable. Depending on the following elements -- landscape setting, the viewers, and the facility siting and design -- aquaculture can have a positive or negative impact on an area’s visual quality. An overview and assessment of these elements is provided in the following subsections and is discussed in terms of the Project in Sections 2.2 and 2.3, Gallagher Cove and North Totten, respectively.

2.1.1 Landscape Setting

The environmental condition of the landscape, its spatial definition, adjacent scenery and bank height all affect the potential for visual impact. A permanently visible aquaculture facility along a pristine shoreline may degrade its scenic quality, while the same facility along an industrial shoreline may enhance its visual quality. Rural, residential and commercial shorelines lie in between these two extremes. Open shorelines and large embayments are generally less susceptible to visual impact than small, enclosed embayments. Concave embayments focus the viewer’s attention on the flat plane of the water; floating aquaculture facilities generally disrupt the plane and are visually evident. Landforms and vegetation can frame and focus views and heighten the viewer’s attention; aquaculture facilities located in these areas will have a higher potential for visual impact. As the height of the adjacent shoreline increases, an aquaculture facility (which is generally low and horizontal with the water surface) will become more visually evident. The viewer’s line of sight is now more perpendicular to the plane of the water, and the foreshortening of objects on the water has decreased.

2.1.2 The Viewer

The attitude of the viewers, their number, and the duration of their viewing all affect potential visual impact. The potential for visual impact is higher along shorelines where a majority of residents or visitors have a high level of concern for scenic quality. Along the Puget Sound, this includes full-time and temporary residents with views of the water, those who visit public parks and use areas, and those who travel scenic highways. This potential increases as the number of
viewers and their viewing time increases. Conversely, aquaculture facilities may be a source of visual interest as an intrinsic Puget Sound industry. Out of curiosity, people may wish to visit, examine, and understand their operation.

2.1.3 Facility Siting and Design

Five major siting and design variables affect potential visual impact. They are distance offshore; solar orientation; vertical profile; size and surface coverage; and color, materials, and form. At distances greater than 1,500 to 2,000 feet offshore, the visual presence of most facilities is reduced to a line near the horizon. At this distance, size and surface coverage doesn’t seem to affect visual impact. Closer to the shoreline, those facilities with limited surface coverage or those with dispersed buoys or rafts have less visual impact than those with a large surface area or continuous coverage. Facilities which repeat the flat plane of the water have less visual impact than those which project vertically above the water surface. Sky conditions, sun angle, wind, and direction of view all affect color. In general, blues and greens complement the natural setting; greys and earth tones are neutral; white and black are highly variable in their response to lighting conditions; and oranges, yellows and reds have a high visual presence. Although highly variable, the glare of the sun off the water, or the shadow cast by adjacent landforms, can obscure aquaculture facilities. Finally, those facilities which borrow from structures and forms already in the marine environment (pilings, docks, marinas) can minimize visual impact.

2.1.4 Visual Assessment

The inventory and evaluation rating sheets from the Study’s Visual Assessment Workbook were used to assess each of the two sites. Copies of these sheets are provided in Appendix A; sheet ratings and an overall summary are provided in each of the following two subsections. Copies of the inventory and evaluation rating sheets from the Study were completed in the field, confirmed upon further review, and are summarized below. The rating sheets are organized by component and sub-category (e.g., Scenic Quality and Spatial Definition, respectively); the sub-category is described; and a high, moderate, and low set of attributes, descriptions, and values are provided. The values are 1 – high value, 0 – moderate value, and -1 – low value. A summary sheet is provided on which the total values for each sub-category are combined to determine the overall value with regard to the component being evaluated. The final sheet provides the evaluator with a method to determine the extent of probable visual impact at the Project site; ranging from severe, high, moderate, to low visual impact. The overall visual assessment methodology (site inventory and analysis process) is illustrated in Figure 2.1 and provided in further detail in Appendix A. In addition to using the rating sheets provided in the Study, and due to the recognition of potentially higher visual intrusion, a scaled visual simulation of the North Totten mussel rafts was developed to assist in the analysis of the proposed Project at that site.
2.2 Gallagher Cove Inventory and Analysis

2.2.1 Landscape Setting

Environmental Conditions The Gallagher Cove mussel rafts site is within the viewshed of two low density residential areas; Mirimichi Beach to the west and Boston Harbor Waterfront to the east. The environmental conditions of these two upland areas can be characterized as rural. The natural environment is culturally modified, but attractive. Homes and small areas of cleared vegetation dot the shoreline and are surrounded by second and third growth timber, both within Gallagher Cove and further northward on either side of Totten Inlet. Their is clear evidence of human activity, but not at a dominating level or to the detriment of the area. As shown in Photo 1, the existing mussel rafts are apparent from both areas surrounding Gallagher Cove, as are several small residential docks and moorings.

Spatial Definition The Totten Inlet is a large embayment with open shorelines and confined coves. Gallagher Cove is a relatively confined area, however, the existing (and proposed) mussel rafts are sited far enough waterward so that they are viewed against the larger Totten Inlet area as opposed to the confines of the cove itself.
Photo 1. Existing view of Gallagher Cove mussel rafts site and northward up Totten Inlet as seen from Mirimichi Beach approximately 75 feet above the shoreline.

Adjacent Scenery Open water and the existing mussel rafts compose the foreground view; narrow beaches, low banks, and fairly dense vegetation with open pockets of homes and cleared areas make up the middle ground; and southern Puget Sound compose the background view. Colors range from the dominant blue-greens of the water to the dark greens of the upland vegetation. A light brown strip of land forms the shoreline between the water and upland areas. Darker browns and specks of white make up the homes and rooftops and can be seen in the middle ground as viewed from either of the residential areas. In general, there is a moderate level of form, line, color, and texture; some surface variation but no overly prominent features; mature vegetation but generally in a continuous pattern; and the adjacent scenery is mostly within the range of a quarter to one mile away.

Bank Height The homes within the Mirimichi Beach area are located along the bluff top and range from about 40 to 80 feet above the shoreline. The Boston Harbor Waterfront homes are located on lower banks ranging from about five to 25 feet above the Gallagher Cove shoreline.

2.2.2 The Viewer

Viewer Expectations Mussel rafts at Gallagher Cove are part of the existing landscape and view and have an affect on viewer expectations related to offshore views from the residences from the surrounding areas. While the affected viewers may be sensitive to changes to their current views, the existence of the mussel rafts and other man-made structures at this location are likely an accepted part of the landscape by the surrounding residences. Therefore, it can be assumed that, in general, viewer expectations exposed to the Gallagher Cove mussel rafts site can be categorized as moderate.
Number of Viewers  The area surrounding Gallagher Cove is composed of two low density residential areas set within a rural environment; Mirimichi Beach to the west and Boston Harbor Waterfront to the east. The total number of viewers can be categorized as low.

View Duration  Because the majority of the viewers live in the residences surrounding Gallagher Cove the potential exists for sustained views. This factor would indicate a high viewer sensitivity level in regards to view duration.

2.2.3 Facility Siting and Design

Distance Offshore  The current set of mussel rafts are located approximately 500 feet from the Boston Harbor Waterfront shoreline and about 1,200 feet from the Mirimichi Beach shoreline. The new set of mussel rafts would be situated directly adjacent to the current rafts, placing them approximately 600 feet from the Boston Harbor Waterfront shoreline and about 1,000 feet from the Mirimichi Beach shoreline. Views of the proposed rafts from these locations would be from approximately 15 to 85 feet above the adjacent shorelines.

Solar Orientation  From the Mirimichi Beach residences, views of the site look northward (as seen in Photo 1), from the Boston Harbor Waterfront residences views of the site generally look toward the west.

Vertical Profile  The mussel rafts would generally rise between one and two feet above the surface of the water and would maintain the low profile of the current rafts.

Size and Surface Coverage  The amount of rafts and size of the farm at this site would be doubled from its current configuration of seven 3-unit raft structures to seven 6-unit raft structures; adding 21 additional rafts to the site. Each raft is 30 feet by 34 feet, and a 6-unit raft structure consists of a total of six rafts. As shown in Figure 1.2, the size of the expanded farm would be 360 feet by 500 feet (4.13 acres). The raft’s surface coverage would be less than that of the overall size of the site due to the 40 foot spacing allowed between the six-unit raft structures. Therefore, the overall surface coverage would be less than a quarter the size of the overall site — 42,840 square feet (0.98 acres).

Color, Materials, and Form  The new rafts would look much the same as the existing rafts. The rafts would be constructed from unpainted lumber and would be allowed to age and weather naturally; turning them from an initial medium brown color to eventually a lighter brownish-gray color. The devices used for flotation are typically reused blue or white plastic 50 gallon barrels obtained from the cider industry. These would likely be underwater the majority of time where they would accumulate growth from their exposure to the marine environment. Eventually, they
would become mottled and take on a greenish-blue color. The overall form of the raft units would look much the same as seen in Photo 1, except the amount of water surface covered by rafts at this location would be doubled. The new rafts would also be organized into a form which brings the structures together in a more orderly arrangement. Spacing between the raft units would be maintained allowing water to be seen between them.

2.2.4 Visual Assessment

The site was inventoried and evaluated, and photographs taken during a site visit on April 4, 1997 from 11:45 a.m. to 12:30 p.m. All photographs were taken from a residence atop the bluff overlooking Gallagher Cove using a 35 mm camera with a 50 mm lens. Thus, each frame (individual photograph) represents approximately a 60 degree cone of vision. This is the amount of a given scene a viewer (assuming 20:20 vision) is able to see from a static setting (i.e., eyes only looking in a straight-forward direction). The camera was set on a tripod approximately five feet above the surface of the ground which was about 70 feet above the shoreline. Figure 2.2 shows the key observation points from which the photographs were taken relative to the proposed rafts. Tides during this time period were going from the first low of 3.9 feet at 8:30 a.m. to the second high of 9.8 feet at 2:04 p.m. (Seattle Post-Intelligencer, April 4, 1997).

Gallagher Cove Inventory and Evaluation Sheets

Sheet No. 1
- Component: Scenic Quality
- Sub-category: Environmental Condition
- Description: Capacity of the landscape to accept human alteration without losing its natural visual character.
- Category: Moderate [0 value]

Sheet No. 2
- Component: Scenic Quality
- Sub-category: Spatial Definition
- Description: Degree of spatial enclosure and volume created by the flat plane of the water body and the surrounding landforms.
- Category: Moderate [0 value]
Source: Taylor Resources, Inc.

Figure 2.2  Key Observation Points

Not to Scale
Sheet No. 3

- Component: Scenic Quality
- Sub-category: Adjacent Scenery
- Description: Adjacent Shoreline edge, landform, and vegetation which define embayment. Influence, detail, and clarity diminish with distance. In general, impact of this variable increases as the degree of enclosure increases, or as the embayment size or the distance to the opposite shoreline decreases.
- Category: Moderate [0 value]

Sheet No. 4

- Component: Scenic Quality Summary
- Description: Evaluation of individual scenic quality factors (from sheets 1 - 3, above) to determine overall site scenic quality.
- Category: Moderate [0 value]

Sheet No. 5

- Component: Sensitivity Level
- Description: Number of potential viewers, related to adjacent travel routes, use areas, or existing residential development.
- Category: Moderate [0 value]

Sheet No. 6

- Component: Visibility
- Sub-category: View Obstruction
- Description: Degree of obstruction in viewing the water by vegetation, landform, or man-made objects.
- Category: High [1 value]

Sheet No. 7

- Component: Visibility
- Sub-category: Distance Offshore/Observer Position
- Description: Visibility critically related to distance offshore and height of key observation points above sea level. Influence, detail, clarity, and scale diminishes as distance offshore increases. Foreshortening and scale diminishes the nearer the observer position is to sea level.
- Category: Moderate [0 value]
Sheet No. 8
- Component: Visibility
- Sub-category: Viewshed Coverage
- Description: Percentage of normal cone of vision occupied by proposed aquaculture facility. Requires project sets and photographs taken with a normal lens (50 mm), or computer simulations. In general, applies to projects located less than 1,500 to 2,000 feet offshore.
- Category: Low [-1 value]

Sheet No. 9
- Component: Visibility Summary
- Description: Evaluation of individual visibility factors (from sheets 6 - 8, above) to determine overall visibility.
- Category: Moderate [0 value]

Sheet No. 10 -- Analysis of Visual Impact
- Description: Determination of four levels of visual impact (severe, high, moderate, low) through the synthesis of scenic quality, sensitivity level, and visibility.
- Category: Moderate Visual Impact

Conclusion

Using the rating sheets and methodology outlined in the Study it has been shown that expansion of the Gallagher Cove site would cause a moderate visual impact. The mussel rafts would be permanently visible and visibly evident from both the key observation point at Mirimichi Beach, and the from the shoreline along the Boston Harbor Waterfront area. However, the type of landscape setting and viewers, combined with the siting and design of the facility would continue to allow it be subordinate to the Project setting.

2.3 North Totten Site Inventory and Analysis

2.3.1 Landscape Setting

Environmental Conditions  The Totten Inlet mussel rafts site is within the viewshed of a low density residential area located along the shoreline approximately one mile north of the Gallagher Cove mussel raft site. The environmental conditions of this area are similar to those surrounding the Gallagher Cove site. The area is rural and although the natural environment is culturally modified, it is attractive. Homes and small areas of cleared vegetation dot the shoreline and are surrounded by second and third growth timber. Their is clear evidence of human activity, but not at a dominating level or to the detriment of the visual quality of the area. Photos 2 and 3 show
low and high tide views toward the proposed mussel rafts site. Photo 2 (at low tide) was taken from a residential yard along the shoreline adjacent to the proposed raft site. Photo 3 (at high tide) was taken from the second floor deck of the same residence.

Photo 2. Existing view towards proposed North Totten mussel rafts site with Windy Point beyond. As seen at low tide from approximately 25 feet above the shoreline (base of bulkhead).

Photo 3. Existing view towards proposed North Totten mussel rafts site with Windy Point beyond. As seen at high tide from approximately 40 feet above the shoreline (base of bulkhead).

Spatial Definition The Totten Inlet is a large embayment with open shorelines and confined coves. The North Totten site is located along an open portion of the inlet and affords an open view towards the Mason County side of Totten Inlet. Windy Point, to the north, is approximately a half mile across from the proposed raft site (as seen in the middle part of Photos 2 and 3); the inlet cuts in as it extends to the south with views to about one and a half miles across the inlet (as seen in the left hand side Photos 2 and 3).
Adjacent Scenery  At low tide the bulkhead, tidelands, and shoreline compose the foreground view; open water makes up the middle ground; and narrow beaches, bluffs, and fairly dense vegetation with open pockets of homes and cleared areas compose the background view. On a clear day, the snowcapped peaks of the Olympic mountains can be seen in the far off distance. Colors are similar to those at the Gallagher Cove site; they range from the dominant blue-green-grays of the water to the dark greens of the upland vegetation. A light brown strip of land forms the shoreline between the water and upland areas. Darker browns and specks of white make up the homes, rooftops, and banks and can be seen in the background as viewed from the residential area. In general, there is a moderate level of form, line, color, and texture; some surface variation, but no overly prominent features; mature vegetation, but generally in a continuous pattern; and the adjacent scenery is mostly within the range of up to a mile and a half away.

Bank Height  The homes adjacent to the proposed raft site are located along the shoreline and range from about 15 to 40 feet above the shoreline or base of the bulkhead. Homes on the opposite side of the inlet are located from approximately 15 feet to 70 feet above the shoreline.

2.3.2  The Viewer

Viewer Expectations  Viewers at this location are used to open water views that are generally unobstructed by permanent man-made water features. Therefore, it can be assumed that, in general, viewer expectations at the proposed North Totten mussel rafts site can be categorized as highly sensitive to view modifications.

Number of Viewers  The area adjacent to the proposed raft site is composed of a low density residential area set within a rural environment. There are about 10 to 15 residences that would have sustained views of the proposed rafts. Therefore, the total number of viewers can be categorized as very low.

View Duration  Because the majority of the viewers live in the residences adjacent to the proposed raft site, sustained views are likely. Most of the lots, and homes on them, face toward the west down the length of Totten Inlet. Photos 4 and 5 are panorama views taken during low tide and high tide from the same locations as Photos 2 and 3. Right of center, as framed in these photos, is what constitutes the primary views from these residences. In other words, the proposed rafts would be located north of these primary views, and thus would be in the right to far right-hand side of the majority of those viewers in this residential area. These two factors (sustained views, but generally focused away from the proposed rafts) would indicate a moderate to high viewer sensitivity level in regards to view duration for the majority of the viewers that would be exposed to views of the proposed rafts.
Photo 4. Panorama of North Totten site taken at low tide from approximately 25 feet above base of bulkhead. Framed area is same portion shown in Photos 2 and 6.

Photo 5. Panorama of North Totten site taken at high tide from approximately 40 feet above base of bulkhead. Framed area is same portion shown in Photos 3 and 7.
2.3.3 Facility Siting and Design

Distance Offshore  The proposed mussel rafts would start at approximately 600 feet from the adjacent shoreline and extend waterward about another 600 feet. Views of the proposed rafts would be mainly from approximately 5 to 40 feet above the adjacent shorelines.

Solar Orientation  From the adjacent residences, views of the site generally look toward a northward direction (as seen in Photos 4 and 5).

Vertical Profile  The mussel rafts would generally rise between one and two feet above the surface of the water and would have a low profile with the water surface.

Size and Surface Coverage  The amount of rafts and size of the mussel farm at this site would be composed of six 7-unit raft structures and two 8-unit raft structures. Each raft is 30 feet by 34 feet, therefore, this site would have a total of 58 rafts. As shown in Figure 1.3, the size of the farm would be approximately 700 feet by 650 feet (10.45 acres). The raft’s surface coverage would be less than that of the overall size of the site due to the spacing allowed between raft structures. The overall surface coverage would be approximately 63,100 square feet (1.45 acres).

Color, Materials, and Form  The new rafts would look much the same as the existing rafts at the Gallagher Cove site (Photo 1). The rafts would be constructed from unpainted lumber and would be allowed to age and weather naturally; turning them from an initial medium brown color to a lighter brownish-gray color. Typically, 50 gallon barrels are used as flotation for the rafts. These are reused plastic cider barrels of a medium blue or white color. They would likely be underwater the majority of time where they would accumulate growth from their exposure to the marine environment. Eventually, they would become mottled and taken on a greenish-blue color. The overall form of the raft units would also look much the same as the existing rafts at the Gallagher Cove site, except the amount of water surface covered by rafts at this location would be approximately twice the amount seen in Photo 1. The new rafts would also be organized into a form which brings the structures together in a more orderly arrangement (see Figure 1.3). Spacing between the raft units would be maintained allowing water to be seen between them when viewed at an angle.

2.3.4 Visual Assessment

The site was inventoried and evaluated, and photographs taken during a site visit on August 13, 1997. Photographs were taken at the following two different times during the day under different climatic conditions: (1) 9:15 a.m. at low tide, overcast sky with southwesterly winds blowing at about five to ten miles per hour; and (2) 2:15 p.m. at high tide, relatively clear, blue sky with
some high clouds above and on the horizon. The photographs were taken from two different locations at one of the closest residences adjacent to the proposed raft site. A 35 mm camera was used with a 50 mm lens. The key observation points from which the photographs were taken relative to the proposed rafts are shown on Figure 2.1. For the morning photographs, the camera was set on a tripod approximately five feet above the surface of the ground which, at the morning location (low tide), was about 25 feet above the base of the bulkhead. For the afternoon photographs, the camera was set on a tripod approximately five feet above the surface of a second floor deck which, at the afternoon location (high tide), was about 40 feet above the base of the bulkhead. Tides during these two time periods went from the first low of 0.8 feet at 7:20 a.m. to the first high of 9.2 feet at 2:45 p.m. (Seattle Post-Intelligencer, August 13, 1997).

**North Totten Inventory and Evaluation Sheets**

**Sheet No. 1**
- Component: Scenic Quality
- Sub-category: Environmental Condition
- Description: Capacity of the landscape to accept human alteration without losing its natural visual character.
- Category: Moderate [0 value]

**Sheet No. 2**
- Component: Scenic Quality
- Sub-category: Spatial Definition
- Description: Degree of spatial enclosure and volume created by the flat plane of the water body and the surrounding landforms.
- Category: Moderate [0 value]

**Sheet No. 3**
- Component: Scenic Quality
- Sub-category: Adjacent Scenery
- Description: Adjacent Shoreline edge, landform, and vegetation which define embayment. Influence, detail, and clarity diminish with distance. In general, impact of this variable increases as the degree of enclosure increases, or as the embayment size or the distance to the opposite shoreline decreases.
- Category: Moderate [0 value]

**Sheet No. 4**
- Component: Scenic Quality Summary
• Description: Evaluation of individual scenic quality factors (from sheets 1 - 3, above) to
determine overall site scenic quality.
• Category: Moderate [0 value]

Sheet No. 5
• Component: Sensitivity Level
• Description: Number of potential viewers, related to adjacent travel routes, use areas, or
existing residential development.
• Category: Moderate [0 value]

Sheet No. 6
• Component: Visibility
• Sub- category: View Obstruction
• Description: Degree of obstruction in viewing the water by vegetation, landform, or man-
made objects.
• Category: High [1 value]

Sheet No. 7
• Component: Visibility
• Sub- category: Distance Offshore/Observer Position
• Description: Visibility critically related to distance offshore and height of key observation
points above sea level. Influence, detail, clarity, and scale diminishes as distance offshore
increases. Foreshortening and scale diminishes the nearer the observer position is to sea
level.
• Category: High [1 value]

Sheet No. 8
• Component: Visibility
• Sub- category: Viewshed Coverage
• Description: Percentage of normal cone of vision occupied by proposed aquaculture facility.
Requires project sets and photographs taken with a normal lens (50 mm for a 35 mm
camera), or computer simulations. In general, applies to projects located less than 1,500 to
2,000 feet offshore.
• Category: Moderate [0 value]

Sheet No. 9
• Component: Visibility Summary
• Description: Evaluation of individual visibility factors (from sheets 6 - 8, above) to
determine overall visibility.
• Category: High [2 value]

Sheet No. 10 -- Analysis of Visual Impact
- Description: Determination of four levels of visual impact (severe, high, moderate, low) through the synthesis of scenic quality, sensitivity level, and visibility.
- Category: Moderate to High Visual Impact

Conclusion

Using the rating sheets and methodology outlined in the Study it is apparent that the rafts proposed at the North Totten site would cause a moderate to high visual impact. The mussel rafts would be permanently visible and visibly evident from the key observation point, as well as from the several residences on either side of the key observation point. As a result of these findings, computer-generated visual simulations of the proposed rafts were developed to further assess the Project at this location.

The simulations were derived from the set of photographs taken during the August 13, 1997 field visit. They were developed using computer aided design (CAD) software to build an accurate model of the proposed raft structures and place them in the appropriate place in the photographs. PhotoShop (a photo enhancement computer software program) was then used to fill-in and color the model to more accurately represent the actual form and color of the rafts. The brown of the rafts shown in the simulated photographs illustrates the color of the rafts after first being constructed and placed at the North Totten site. Over time they would weather to take on a somewhat light brownish-gray color.

Photo 6 shows the existing conditions at low tide as seen from about 25 feet above the base of the bulkhead; it is the same as photograph as Photo 2. Photo 7 is a duplicate of Photo 6 with the raft structures placed as they would be in the proposed Project. Photo 8 shows the existing conditions at high tide as seen from about 40 feet above the base of the bulkhead; it is the same as photograph as Photo 3. Photo 9 is a duplicate of Photo 8 with the raft structures placed as they would be in the proposed Project.

These simulations show that the rafts would cause a visual obstruction to a view that is otherwise relatively free of other permanent man-made water features. The exception being several old wooden pilings just northeast of the proposed raft site (as seen in Photos 6 and 7). As previously described, viewer expectations, duration, and the number of viewers are all important to gaining an understanding and assessing the potential level of impacts the Project may have on visual resources. Also discussed were several other factors that must be considered when analyzing the Project’s potential level of impact to visual resources, including: the environmental conditions of
the landscape, its spatial definition, adjacent scenery, and bank height. Also important are the siting and design of the facility, including: distance offshore; solar orientation; vertical profile; size and surface coverage; and color, materials, and form. Together, all of these factors affect the potential for the Project to cause some level of visual impact on the area’s visual resources. When considering all of these factors together, it can be determined the siting and design of the facility in the context of its landscape setting and low number of viewers would allow the mussel rafts to remain subordinate to the Project setting as a whole. Therefore, it has been determined through this analysis that of the four levels of possible visual impact the Project would likely have a moderate visual impact on the area’s visual resources.
Photo 8. Existing conditions at high tide. Photo taken at 1:00 p.m. from approximately 40 feet above base of bulkhead.

Photo 9. Future conditions at high tide with proposed mussel rafts.
Photo 6. Existing conditions at low tide. Photo taken at 9:00 a.m. from approximately 25 feet above base of bulkhead.

Photo 7. Future conditions at low tide with proposed mussel rafts.
3.0 ECOLOGICAL CONCERNS ASSESSMENT
3.0 Ecological Concerns Assessment

As mentioned, the County requested that further assessment of the Project be undertaken as part of Taylor’s SEPA compliance documentation in order to address the Project’s potential impacts related to specific ecological concerns, i.e., tidal flushing, carrying capacity, and waste production, associated with the Totten Inlet ecosystem. These are important elements with regard to the ability to farm mussels, the health of aquaculture in general, as well as to the overall Totten Inlet ecosystem. Adequate tidal flushing is needed in a given system to enable new food resources to enter and waste materials to be carried out of the system. Likewise, an ecosystem’s carrying capacity must remain in balance in order to avoid significantly disrupting the overall health of the system. Finally, it is important that the waste produced in a given system be effectively removed to avoid impacting the area. This section discusses each of these concerns in greater detail and provides conclusions based on available data. It also provides a summary of how bivalves can play an important role as ecosystem stabilizers, and Project recommendations/mitigation measures.

3.1 Tidal Flushing

Tidal flushing or water mass residence time is the theoretical time it takes for the volume or mass of water within a basin to be replaced with water from outside the system. In bivalve culture, as in other aquaculture and natural marine processes, tidal flushing is used as an ecosystem scale parameter. It is important because it can be the source of new food resources, i.e., phytoplankton, and the main means of carrying away waste materials produced by the bivalves.

Puget Sound Perspective

The ways in which tidal flushing have been calculated for Puget Sound’s component inlets, bays, basins, and arms, vary considerably; the methods associated with the estimates are briefly described in this section. Estimates of flushing have been made for a number of areas within the Puget Sound. Table 3.1 provides a summary of readily available estimates. These calculations assume that the substance being flushed is conservative, i.e., it undergoes no interactions with the sediments, chemistry or biology; basically, the substance is inert as it wanders with the currents.

In general, the flushing estimates vary 600-fold, from one day to approximately two years: The fastest flushing (one day) occurred because the rapid currents in adjoining Admiralty Inlet quickly replaced the waters in Port Ludlow. The longest flushing, or oldest water in Puget Sound, occurs when water becomes trapped behind the sill at the entrance to Dabob Bay, a side inlet of Hood Canal. The flushing of Puget Sound as a whole as well as sub-segments, including Southern Puget Sound south of The Narrows were estimated using a refluxing model developed
by Cokelet, Stewart and Ebbesmeyer (1988, 1991). Time scale of southern Puget Sound considers refluxing (i.e., all resident water is replaced with new water) within and throughout the Puget Sound. Note that most of the refluxing here is in the large volumes of transport in the Devils Head and Gordon Points zones (transports of 15,000 and 5,000 cubic meters per second, respectively).

Table 3.1 Previous estimates of flushing in Puget Sound ordered from shortest (Port Ludlow) to longest (Dabob Bay).

<table>
<thead>
<tr>
<th>Water Body</th>
<th>Approximate Flushing Time (days)</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Ludlow</td>
<td>1</td>
<td>Tidal currents removed all but 4 of 300 drogues from the Bay in a day.</td>
</tr>
<tr>
<td>Oakland Bay &amp; Hammersley Inlet</td>
<td>8</td>
<td>Water body salinity response to a rain event.</td>
</tr>
<tr>
<td>Totten Inlet</td>
<td>10</td>
<td>Inlet volume/net volume transport.</td>
</tr>
<tr>
<td>Budd Inlet</td>
<td>10</td>
<td>Dye injection into a hydrodynamic computer model.</td>
</tr>
<tr>
<td>Southern Puget Sound (south of The Narrows)</td>
<td>90</td>
<td>Refluxing model.</td>
</tr>
<tr>
<td>Hood Canal</td>
<td>125</td>
<td>Refluxing model.</td>
</tr>
<tr>
<td>Dabob Bay</td>
<td>600</td>
<td>Monthly oxygen measurements made below sill depth.</td>
</tr>
</tbody>
</table>

Sources: Cokelet et al., 1988; Oley, 1959

**Tidal Flushing of Totten Inlet**

The approximate flushing time for Totten Inlet is estimated to be 10 days. The tidal flushing of Totten Inlet was estimated using the following three methods: (1) daily changes in the Inlet's volume due to tides (the intertidal volume); (2) transports computed from current meter measurements; and (3) budgets of salt and fresh water. These methods are described in further detail below.

**Intertidal Volume**

The tides in Puget Sound undergo two highs and two lows each day. Table 3.2 lists the volumes of Totten Inlet as determined at the University of Washington by Peter McLellan (1954). Two volumes were extracted from McLellan's data with respect to tidal levels; the volume below Mean-High-Water (MHW), and the volume below Mean-Lower-Low-Water (MLLW). The volume below MHW is taken as the total volume of Totten Inlet, and that between MHW and MLLW is referred to as the intertidal volume. Approximately 90 million cubic meters of marine water flow into and out of Totten Inlet between the average highest tide and average lowest tide.
each day (approximately a 12.4-hour time period), or about 42 percent of the Inlet's total volume. The equivalent volume transport equals approximately 2,000 cubic meters per second. This intertidal exchange is ten-fold larger than the net volume transport when the currents are averaged over many tidal cycles.

Table 3.2. Volumes\(^1\) of Totten Inlet.

<table>
<thead>
<tr>
<th>Volume definition</th>
<th>Value (cubic meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total volume below MHW</td>
<td>213,000,000</td>
</tr>
<tr>
<td>Intertidal volume between MHW and MLLW</td>
<td>90,200,000</td>
</tr>
<tr>
<td>Ratio of intertidal to total volume (2/1)</td>
<td>0.42</td>
</tr>
</tbody>
</table>

\(^1\)Volumes inside the line across the entrance (approximately Steamboat Island) to Totten Inlet including Skookum Inlet. Source: McLellan (1954).

Tidal Flushing Time From Current Meter Measurements

The flushing (residence) time may be estimated as the Inlet's total volume divided by the net volume transport. This is the time to replace the Inlet's water, assuming zero refluxing. Refluxing for Totten Inlet is complex because of exchanges with Hammersley Inlet and Pickering Passage.

Net volume transports in Totten Inlet were estimated in two ways. First, from current meter measurements in the Inlet entrance, and second, from observations of salinity and river discharge (referred to as the water budget method). Currents were measured approximately hourly at 5 meters depth in the entrance of Totten Inlet during 2-6 February 1945 immediately northwest of Steamboat Island (4 tidal days of measurements at 47\(^\circ\)11.4' North latitude, 122\(^\circ\)56.7' West longitude). Vector analysis of the current meter record yielded a net current speed of 8 cubic meters per second directed toward the southwest. Net volume transport (240 cubic meters/sec) was computed from this net velocity vector by multiplying by the cross sectional area (8,000 square meters) and two factors, based on the author's\(^1\) experience in Puget Sound, necessary to adjust for cross channel (0.75) and vertical variations (0.5) of the currents.

Tidal Flushing Computed From Water Property Budgets

Volume transport was computed from measurements of salinity and river runoff used in mass and salt budgets for Totten Inlet (Table B4 in URS, 1986). Eleven estimates from data obtained during the time period from August 1957 to October 1958 yielded a mean net volume transport of 250 cubic meters per second (standard error = 41 cubic meters/sec).

---

\(^1\) Curtis Ebbesmeyer, Ph.D. Oceanographer, Evans and Hamilton.
Tidal Flushing Estimate

Though both methods for computing net volume transport into Totten Inlet involve assumptions, the approximate agreement between estimates obtained from current measurements (240 cubic meters/sec) and water property budgets (250 cubic meters/sec), suggests that the actual transport lies between 200-300 cubic meters per second. For the purposes of this report the average of the two estimates, or 245 cubic meters per second is used. The ten-day flushing time calculated for Totten Inlet was taken as the volume at MHW (213,000,000 cubic meters; Table 3.2), divided by the net volume transport at the entrance to the Inlet (245 cubic meters/sec).

Ecosystems with massive and successful bivalve populations generally have water mass residence times of less than 40 days (Smaal and Prins 1993; Dame and Prins in press). The estimated tidal flushing of Totten Inlet of 10 days or fewer supports this area as an environment that can maintain intense bivalve culture.

As indicated in Table 3.1, the tidal flushing time in Dabob Bay is estimated to be about 600 days. The bay is deep and has a sill at its mouth (this sill acts as an underwater dam that traps water for long periods of time). In this respect is quite different than Totten Inlet which is relatively shallow in comparison and has no sill. Nevertheless, Dabob Bay does support a significant shellfish population and is important to the shellfish industry. It is one of the few areas in the Puget Sound where oysters naturally reproduce and is a popular larvae catch area.

3.2 Carrying Capacity

When the biomass of a species ceases to accumulate, i.e., growth declines or stops, the system is said to have reached carrying capacity. The amount of biomass supported under these conditions is termed maximum carrying capacity (Odum 1983). Experience shows that the optimum carrying capacity sustainable for long periods of time is usually lower (Odum 1983). Thus, carrying capacity is generally defined as the biomass of animals in a population that can be supported permanently by a given system (Krebs 1978).

Water mass flushing time, phytoplankton replacement time and bivalve clearance time all influence the carrying capacity of a given system. Phytoplankton replacement time is the time it takes for primary production within the system to replace the standing crop biomass of phytoplankton within the system. Bivalve clearance time is the time that is theoretically needed for the total bivalve filter feeder biomass within an ecosystem to clear (filter) that system of phytoplankton (Smaal and Prins 1993).
In their review, Smaal and Prins (1993) noted that in those ecosystems with intensive and successful bivalve culture the ratio of bivalve filter feeder biomass to water volume ranged from 2 to 8 grams dry body (gdb) m\(^{-3}\). Thus, the ratio of bivalve biomass to water volume is an approximate quantitative first estimate of the potential carrying capacity of a given system.

As shown in Table 3.3, the present biomass of bivalves in Totten Inlet at any given time is conservatively estimated at about 2.0 x 10\(^8\) gdb. The proposed mussel rafts at North Totten and Gallagher Cove would add about 5.28 x 10\(^7\) gdb of mussels to Totten Inlet. Therefore, it is roughly estimated that the future annual total bivalve biomass in Totten Inlet would be about 2.53 x 10\(^8\) gdb. Dividing the annual mussel biomass by the water volume of Totten Inlet (about 2.13 x 10\(^8\) m\(^3\)) yields a value of 1.19 gdb m\(^{-3}\). This value is considerably less than that noted in the review by Smaal and Prins (1993).

Utilizing the same data presented in Table 3.3 and bivalve filter feeder pumping formulae reported by Jorgensen (1990), it is shown that the present bivalves within Totten Inlet can clear the water mass in approximately 13.5 days. With the additional mussels on the proposed rafts, the clearance time decreases to about 8.9 days. Thus, clearance time and water mass (tidal) flushing time are similar. A comparison of these turnover times to several other ecosystems is given in Figure 3.1. The Totten Inlet system falls among the major producing systems reported in this review from Dame and Prins (in press).

### 3.3 Waste Production

As a byproduct of their feeding and metabolism, mussels produce feces and pseudofeces as large particulate matter, and dissolved materials in the form of ammonium and inorganic phosphate. The dissolved materials are readily and actively taken-up by phytoplankton and form a link in the positive feedback loop of these nutrients in estuaries (Dame 1996). The particulate waste is denser than water and will sink to the bottom under low flow or no flow conditions. Bivalve feces and pseudofeces are easily resuspended and carried away at an erosional velocity (current speed) of 10 to 15 centimeters per second (Dame 1996). Therefore, this rate can be considered the threshold current speed for resuspension of bivalve feces and pseudofeces.

If these enriched organic sediments accumulate, they may through bacterial decomposition gradually transform the substrate into an anaerobic environment. Such an environmental transformation can lead to a decrease in oxygen concentrations within the water column and become a threat to the well being of the bivalves. Because the production of feces and pseudofeces by filter feeding bivalves is so dependent on the amount and type of suspended particulate material in the water column, it is almost impossible to accurately determine the potential production of these materials.
### Table 3.3 Present and Proposed Bivalve Biomass in Totten Inlet with Pumping and Clearance Times

<table>
<thead>
<tr>
<th></th>
<th>Total Pounds</th>
<th>Wet Body Pounds</th>
<th>Dry Body Pounds</th>
<th>Dry Body Kilograms</th>
<th>Number Individuals</th>
<th>g db/indiv</th>
<th>Pumping Rate liters/hr/indiv</th>
<th>Pumping Rate liters/day/indiv</th>
<th>Total Pumping Liters/day</th>
<th>m³/day</th>
<th>Clearance Time Days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Present Bivalves</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clams</td>
<td>6.00E+06</td>
<td>1.50E+06</td>
<td>3.00E+05</td>
<td>1.36E+05</td>
<td>9.00E+07</td>
<td>1.512</td>
<td>3.53E+00</td>
<td>8.47E+01</td>
<td>7.63E+09</td>
<td>7.63E+06</td>
<td></td>
</tr>
<tr>
<td>Geoducks</td>
<td>4.66E+05</td>
<td>1.17E+05</td>
<td>2.33E+04</td>
<td>1.06E+04</td>
<td>1.99E+05</td>
<td>53.1099</td>
<td>4.92E+01</td>
<td>1.16E+03</td>
<td>2.35E+05</td>
<td>2.35E+05</td>
<td></td>
</tr>
<tr>
<td>Oysters</td>
<td>8.80E+05</td>
<td>2.20E+05</td>
<td>4.40E+04</td>
<td>2.00E+04</td>
<td>8.00E+06</td>
<td>2.4948</td>
<td>1.33E+01</td>
<td>3.18E+02</td>
<td>2.54E+09</td>
<td>2.54E+06</td>
<td></td>
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<tr>
<td>Mussels</td>
<td>1.50E+06</td>
<td>3.75E+05</td>
<td>7.50E+04</td>
<td>3.40E+04</td>
<td>2.25E+07</td>
<td>1.512</td>
<td>9.65E+00</td>
<td>2.36E+02</td>
<td>5.32E+09</td>
<td>5.32E+06</td>
<td></td>
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<tr>
<td><strong>Total</strong></td>
<td>8.85E+06</td>
<td>2.21E+06</td>
<td>4.42E+05</td>
<td>2.01E+05</td>
<td>1.21E+08</td>
<td>1.57E+07</td>
<td>1.35E+01</td>
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<tr>
<td><strong>New Mussel Rafts</strong></td>
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<td></td>
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<tr>
<td>North Totten</td>
<td>1.70E+06</td>
<td>4.25E+05</td>
<td>8.50E+04</td>
<td>3.86E+04</td>
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<td>6.03E+09</td>
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<td></td>
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<tr>
<td>Gallagher</td>
<td>6.30E+05</td>
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<td>3.15E+04</td>
<td>1.43E+04</td>
<td>9.45E+06</td>
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<td>9.85E+00</td>
<td>2.36E+02</td>
<td>2.23E+09</td>
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<td><strong>Total</strong></td>
<td>2.33E+06</td>
<td>5.83E+05</td>
<td>1.17E+05</td>
<td>5.28E+04</td>
<td>3.50E+07</td>
<td>8.26E+06</td>
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<tr>
<td><strong>Total Bivalve Biomass</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System</td>
<td>1.12E+07</td>
<td>2.79E+06</td>
<td>5.59E+05</td>
<td>2.53E+05</td>
<td>1.56E+08</td>
<td>2.40E+07</td>
<td>8.88E+00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- **dry body relationships**
  - wet body = 0.25 (total wt [body+shell])
  - dry body = 0.2 (wet body)
  - 1lb = 0.4536 kg
  - dry body kg = 0.4536 (dry body lbs)
- **pumping formulae (Jorgensen 1990)**
  - clams: 2.6Wt *0.74
  - geoducks: 2.8Wt *0.74
  - oysters: 8.8Wt *0.73
  - mussels: 7.8Wt *0.72

Source: Dame 1997; Taylor Resources, Inc. 1997
Figure 3.1 Bivalve Clearance Time & Water Mass Residence Time Among Major Producing Systems.

Within Totten Inlet, drogues (underwater sails riding at approximately 6 meters depth) were tracked in during the 5 day period from 24-28 April 1975, an interval of spring tides. Table 3.4 shows the speeds computed from the drogues tracked along approximately the mid-channel of Totten Inlet during this time period. These speeds approach the maximum that might be expected as they were observed during large tidal ranges near the center of the channel where tidal currents are generally faster than towards the sides of the Inlet.

The few drogue measurements suggest that currents at mid-channel will exceed the threshold speed most, if not all of the time. However, because studies of other inlets indicate that tidal currents decrease in speed near the shore and inlet bottom, current measurements were taken at the North Totten site on 15 September 1997. The current speeds were recorded at a depth of 12 meters above the Inlet bottom, at 15 minute intervals, over a five-hour observation period, providing a total of 21 current speed values. The predicted tides at the entrance of Totten Inlet during the 5-hour observation period shifted from a strong flood tide to a strong ebb tide.
Table 3.4 Drogue speeds (6 meter depth) at approximately mid channel in Totten Inlet during 23-28 April 1975.

<table>
<thead>
<tr>
<th>Area of Totten Inlet</th>
<th>Date</th>
<th>Average speed (cm/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Windy and Sandy points (drogue 5 near midchannel)</td>
<td>28 April</td>
<td>36</td>
</tr>
<tr>
<td>Between Windy &amp; Sandy points (drogues 3 and 4 ~ mid-channel)</td>
<td>24 April</td>
<td>22</td>
</tr>
<tr>
<td>Between Kamilche &amp; Windy points (drogue 4 ~ mid-channel)</td>
<td>25 April</td>
<td>20</td>
</tr>
<tr>
<td>Between Kamilche &amp; Windy points (drogue 6 ~ mid-channel)</td>
<td>27 April</td>
<td>24</td>
</tr>
<tr>
<td>Inside Kamilche Point (mid-channel, drogue 2)</td>
<td>26 April</td>
<td>16</td>
</tr>
</tbody>
</table>

Note: The two sites proposed by Taylor are located between Kamilche and Windy points.
Source: Ebbsmeyer 1975.

Table 3.5 shows the recorded current speed intervals along side the number of times those current speeds were observed. Five of the 21 measured current speeds (approximately one quarter) were below the 10 cm/sec threshold speed. Therefore, it can be assumed that most (approximately three quarters) of the time current speeds will be above the threshold level. Consequently, it is likely that bivalve feces and pseudofeces would be easily resuspended and carried away the majority of the time.

Table 3.5 Tabular Histogram of Current Speeds at the North Totten Site.

<table>
<thead>
<tr>
<th>Speed Intervals (cm/sec)</th>
<th>No. of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>3</td>
</tr>
<tr>
<td>5 - 10</td>
<td>2</td>
</tr>
<tr>
<td>10 - 15</td>
<td>3</td>
</tr>
<tr>
<td>15 - 20</td>
<td>3</td>
</tr>
<tr>
<td>20 - 25</td>
<td>3</td>
</tr>
<tr>
<td>25 - 30</td>
<td>3</td>
</tr>
<tr>
<td>30 - 35</td>
<td>4</td>
</tr>
</tbody>
</table>


3.4 Bivalves As Ecosystem Stabilizers

Because of their filtration capabilities, bivalve filter feeders have often been touted as potential controllers of phytoplankton blooms in shallow tidal systems (Officer et al. 1982). Bivalves have the potential to dominate ecosystems processes because they shorten their food chains, take advantage of tidal energy subsidies to receive their food, and their longer life spans (as compared to plankton) with greater stored biomass stabilizes a given ecosystem over longer time periods
with a greater variety of environmental cycles (Dame 1996). In other words, bivalves are always in the system pumping and filtering, thus, when a phytoplankton bloom begins it is immediately grazed by the bivalves. There is no time lag waiting for the zooplankton population to grow to sufficient size to control the phytoplankton (Herman and Scholten 1990; Heip et al. 1995).

Cultivated bivalves may also be a means of removing excess nutrients, i.e., nitrogen, from systems as the harvested bodies (with their inherent composition of C-N-P) are taken out of the system for consumption elsewhere.

### 3.5 Recommendations / Mitigation Measures

(1) In order to gain a clear understanding of the current speeds at the Project sites, current meter readings should be undertaken at both locations after implementation of each phase of the proposed raft structure projects. Meter readings should be taken for a period of at least one month for each of the sites (one month being the standard measurement reading time for most areas of the Puget Sound). If the readings show slower current speeds than the 10 centimeter/second "threshold" speed at the site(s) for more than 25 percent of the time, and/or there is an obvious buildup of bivalve waste under the rafts, the rafts or raft locations should be modified or adjusted, as necessary.

(2) In order to avoid waste production and carrying capacity problems, farm operations at both sites should include monitoring procedures that accommodate: (a) frequent visual observation for sediment accumulation, and (b) periodic monitoring for oxygen level concentrations.
4.0 CUMULATIVE IMPACT ANALYSIS
4.0 Cumulative Impact Analysis

A cumulative impact is the impact on the environment which results from the incremental impact of the action (i.e., Project) when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The five major areas of concern with regard to cumulative impacts as they relate to aquaculture are marine ecology, upland land use, navigation, visual resources, and access. Each of these is discussed in further detail below.

4.1 Marine Ecology

Intense aquaculture may have detrimental effects on the nearby water and other biological components of the overall ecosystem system from a buildup of digestive waste and an increase in the carrying capacity of the area over that which it is able to accommodate. The cautious approach to dealing with these ecological concerns is to incrementally develop facilities, with testing in between increments to detect possible impacts.

At this writing, there are no other aquaculture projects proposed in the Totten Inlet. Given the size of the Project, the approach in its implementation, and further monitoring and sampling recommended as part of this report, it has been demonstrated that the Project would have a less than significant effect on the overall ecology of Totten Inlet. Nevertheless, any further development of mussel farming in the Project vicinity should be carefully analyzed to maintain the overall health of the Totten Inlet ecosystem.

4.2 Upland Land Use

Residential development comprise the majority of the upland land uses on the Totten peninsula. Most of the peninsula, particularly the areas surrounding both the Gallagher Cove and North Totten project sites, is designated Rural Residential land use and are zoned one unit per five acres. There are currently about 1,200 residential units on the Totten peninsula from the Gallagher Cove area northward. Approximately 250 of these units, representing about 21 percent of the total number, were constructed during the recent seven year period between 1990 and 1996. This level of growth exceeds growth in other parts of unincorporated Thurston County, which as a whole has seen growth during this same time period of about 15 percent (TRPC 1997).

Upland land uses along the Thurston County shoreline adjacent to Totten Inlet are governed by the goals, policies, and regulations contained in both the Thurston County Comprehensive Plan
and the County’s Shoreline Master Program (SMP). The SMP’s Conservancy Environment designation applies to the areas surrounding both the Gallagher Cove and North Totten project sites. The Conservancy Environment designation is designed to protect, conserve and manage existing natural, cultural, and historic resources. Under this designation, shoreline residential development is allowed at a density of one unit per 40,000 square feet of dry land area and a minimum lot width of 100 feet. Lot coverage with impervious surfaces in this environment are not to exceed 30 percent. The basic setback for residential structures is 100 feet from the ordinary high-water mark (TRPC 1990).

There is no sewer service on the Totten peninsula, all residential units on the peninsula rely on septic systems with leach fields to dispose of residential wastewater. The age and maintenance of these septic systems plays a critical role in the health of the offshore environment, as many of these systems flow in the direction of Totten Inlet, particularly those located directly along the shoreline and bluffs. Other concerns related to the offshore environment from upland land uses include the erosion and runoff of shoreline and blufftop soils into Totten Inlet (particularly during construction) and runoff of products used to maintain residential landscapes (e.g., fertilizers and pesticides). In summary, the continued growth and development on the peninsula and aging septic systems from older residences will continue to pose a threat to the health of the offshore environment in Totten Inlet.

4.2 Navigation

Aquaculture, in certain locations or densities, may restrict navigation, making it inconvenient or unsafe. The size and location of the proposed mussel rafts within Totten Inlet would not impede on the present navigational access of the area. As proposed, the aquaculture facilities would be located in designated areas and include navigation hazard lighting and signage as part of raft design. The Project would not pose any discernible threat to navigation in the Totten Inlet.

4.3 Visual Resources

Multiple aquaculture facilities in the same area can have a visual impact higher than the same facilities located separately. The size of the proposed project, size of the embayment, distance offshore, and viewing height all contribute to the potential for cumulative visual resource impacts to occur. Predefining areas where probable visual impacts would be lessened can be accomplished through performance standards or other development controls that would guide projects to locations with low visual access or areas with existing visual disruption.

Given the size of the landscape setting, the number of viewers, and the facility siting and design of the Project, it has been demonstrated that the Project would have less than a significant effect.
on the area’s visual resources. However, any further development of mussel farming in the Totten Inlet should be carefully analyzed to maintain the visual integrity of the area.

4.4 Access

Most aquaculture facilities require land-based access for staging, parking, launching, and storage of equipment and supplies. If several facilities are located adjacent to each other in an area with limited land access, a conflict may arise between aquaculture operators and abutting upland property owners. Shoreline permits for aquaculture can list conditions to address the impacts of staging if they appear to be a concern.

The tidelands adjacent to the Project are owned by the Project proponent, as well as a nearby shoreline and upland area where they conduct activities related to their aquaculture facilities. The primary access to the mussel rafts would be from the areas owned by the Project proponent, and, therefore, would not result in any cumulative impacts related to access.
References


Thurston Regional Planning Council (TRPC). September 1997. *The Profile for Thurston County and the Cities/Towns of: Lacey, Olympia, Tumwater, Bucoda, Rainier, Tenino, Yelm*. Thurston County Department of Planning.

APPENDICES

Appendix A. State of Washington, Aquaculture Siting Study (pages 61-82)
Visual Impact Assessment

This section provides an analysis of the components of visual impact, and proposes mitigation measures to maintain the Puget Sound's scenic quality while allowing development of its aquaculture potential.

Visual Impact

Four interrelated variables affect visual impact from aquaculture facilities. They are the landscape, the viewer, and the location and design of the facility.

LANDSCAPE

The four major components of the landscape which affect visual impact are environmental condition, spatial definition, adjacent scenery, and bank height.

Environmental Condition

Puget Sound settings vary in their capacity to accept human alteration. The addition of structures and activity along a pristine shoreline can degrade its scenic quality, while the addition of the same structures and activity along a highly industrial shoreline has only a minor visual impact.

The Nisqually National Wildlife Refuge and six other federal and state refuges, sanctuaries, or wilderness areas were created to preserve important natural environments of the Puget Sound. Aquaculture facilities, residential docks, marinas and other development in these areas are likely to be inconsistent with the established management goals and guidelines. Aquaculture facilities on Fidalgo Bay, adjacent to the existing oil refineries, would contribute little visual impact. Rural, residential and commercial shorelines lie in between these two extremes.

Spatial Definition

Open shorelines and large embayments are generally less susceptible to visual impact than small, enclosed embayments. Concave embayments focus the viewer's attention on the flat plane of the water. Floating aquaculture facilities disrupt this plane and are visually evident. The degree of visual impact is related to the scale of the facility. The Computer Simulations prepared as part of this study indicate that, in general, when more than ten percent of the normal cone of vision is covered, there is a high visual impact. If all other factors remain constant, a facility located on the one-half mile wide Hale Passage will have a greater visual impact than the same facility located on the four-and-a-half mile wide Samish Bay.

As the Hale Passage photo renderings indicate, visual impact within small embayments is lessened by increasing the viewing distance and by placement of the floats within the shadow cast by Fox Island.
Along uninhabited shorelines, or those with no adjacent travel routes or key observation points, small embayments can limit visual impact. Projecting headlands and forests can obstruct sightlines from opposite shorelines, or from points up and down the shoreline.

Adjacent Scenery

Landforms and vegetation can focus and enframe views, heightening the viewer's attention. Snow-capped Olympic and Cascade mountain peaks, rock outcrops, or other areas of unusual colors, textures, and form provide a visual focus. Narrow channels, valleys and openings in the forest enframe views. Aquaculture facilities located in these areas have a higher visual impact.

Bank Height

The potential for visual impact increases as the height of the adjacent shoreline increases. The higher the observer's position, the more perpendicular the line of sight is to the plane of the water. There is less foreshortening and the facility has higher visual impact. The computer renderings illustrate this effect. At 5 feet above sea level, a facility 300 feet offshore is a broad line on the horizon. At 105 feet above sea level, the same facility fills twenty-five percent of the view cone.

Increasing bank height can also mitigate visual impact. If the observer's position remains the same distance from the shoreline, the view of an increasing area adjacent to the shoreline is obscured by the embankment edge as the height above sea level increases (Figure 49).

THE VIEWER

The three major components related to the viewer which affect visual impact are viewer expectations, the number of viewers, and the duration of the view.

Viewer Expectations

The potential for visual impact is higher in those areas where a majority of residents or visitors have a high level of concern for scenic quality. Along the Puget Sound, this includes full-time and temporary residents with views of the water, those who visit public parks and use areas, and those who travel scenic highways. These people have certain scenic expectations. They generally expect to see a natural setting. The typical Puget Sound image is a combination of water, forest, and snow-capped peaks. It also typically includes evidence of maritime use -- buoys, pilings, docks, wharfs, and marinas. Intrinsically, aquaculture facilities seem compatible within this setting. Visual impact results when a facility or other maritime use is out of character or scale with the existing landscape setting.
Number of Viewers

As the number of viewers increases, the potential for visual impact increases. Aquaculture facilities offshore of high density residential developments or public parks will affect more viewers than those offshore of vacant or agricultural land uses.

View Duration

The potential for visual impact is higher along shorelines where there are sustained views. The longer a viewer scrutinizes a scene, the greater the opportunity to perceive objects and details which are visually disruptive or out of character with the landscape setting. Viewpoints, vistas, public parks, and existing residential or commercial (i.e. restaurants) development encourage sustained viewing. Shorelines with obstructing landforms or vegetation, or shorelines with adjacent high speed travel routes, afford only quick glances.

FACILITY SITING AND DESIGN

Eight major siting and design variables affect potential visual impact from aquaculture facilities. They are distance offshore, solar orientation, vertical profile, size, surface coverage, color, form and materials.

Distance Offshore

Distance offshore to the aquaculture facility is a major determinant of visual impact. In general, the computer and photo renderings indicate that at distances greater than 1,500 to 2,000 feet offshore, a facility is visually evident but not obtrusive. This distance varies with the bank height. At an observer position at or near sea level, a facility 300 feet offshore is a broad line on the horizon. At an observer position 105 feet above sea level, the same facility fills twenty-five percent of the cone of vision; when moved 1,500 feet offshore, it becomes a line on the horizon.

Solar Orientation

Although highly variable, the glare of the sun off the water, or the shadow cast by adjacent landforms, can lessen the visual impact from aquaculture facilities. Particularly when the viewer is looking toward the rising or setting sun, glare can obscure objects floating on the water. Glare increases when the sun is low on the horizon during late fall, winter, and early spring. Shadows cast by adjacent landforms can obscure objects on the water. This is most evident when the viewer is looking south toward adjacent landforms (as shown in the Hale Passage photo rendering).

Vertical Profile

Aquaculture facilities which repeat the flat plane of the water have less of a visual impact than those which project vertically above the water surface. This is especially true when the observer position is
near sea level. Without accompanying workseds, most facilities have a
low horizontal profile.

Size

The visual impact of size is highly variable. It is affected by distance
offshore and the height of the observer's position above sea level. In
general, if within 300 feet of the shoreline most facilities will have a
visual impact; at 300 feet offshore, and an observer's position greater
than 30 feet above sea level, a facility 500 feet in length covers the
width of a normal 60 degree cone of vision. At distances greater than
1,500 feet to 2,000 feet, size doesn't seem to affect visual impact.

Surface Coverage

Facilities with limited surface coverage or those with dispersed buoys or
rafts have less visual impact than those with a large surface area or
those with continuous surface coverage. This is especially true of
facilities with observer positions well above sea level. The five 35 ft.
x 70 ft. rafts shown in the Hale Passage rendering are visually evident,
but because of their relatively small size and the distance between them,
they are unobtrusive from this observer position. The two salmon pens
shown on the Samish Bay rendering have a much higher visual impact. They
cover a much larger surface area and are spaced closer together.

Color

Visual impact due to the color of aquaculture facilities is highly
variable. Sky conditions, sun angle, wind, and direction of view all
affect color. In general, blues and greens complement the natural
setting; greys and earth tones are neutral; white and black are highly
variable in their response to lighting conditions; and oranges, yellows,
and reds have a high visual presence.

Blues and greens complement the dominant colors of the Puget Sound waters
and the surrounding forested hillsides. The Samish Bay renderings
illustrate that under certain light conditions a light aquamarine color
almost disappears against the water. Under different light and viewing
conditions, it is visible but not obtrusive.

Greys and browns are neutral colors. Under overcast skies they would be
unobtrusive colors; although the type of material has an effect on visual
impact. Grey/brown weathered wood is a common and unobtrusive sight
along the Puget Sound, while grey galvanized metal is highly manmade and
tends to be out of place in most natural settings.

White and black are very deliberate colors. Depending on light condi-
tions, they can be nearly invisible or stand out in sharp contrast
against the water. Under overcast skies, looking into a glare, or when
the wind creates a chop on the water, white tends to disappear. As the
Narrows renderings illustrate, under bright sunny skies (when the sun is
high in the sky), white stands out in high contrast to the blue water.
Black has similar characteristics. The black buoys shown in the Hale
Passage rendering disappear in the shadows cast by Fox Island and stand
out against the water with a light value. The black pipe shown in the Fidalgo Bay rendering complements and repeats the oil black pilings of the existing wharf.

Oranges, yellows, and reds have the highest visual impact. All three of these colors are the visual complement of the predominant colors of water: orange/blue, yellow/violet, and red/green. To the human eye, complementary colors are the most intense when adjacent. Because of their intensity and contrast, they are highly visible against each other. Except for limited autumn color, these three colors rarely occur in the natural Puget Sound landscape. When they do occur, they tend to stand out. Because of its high visibility, orange has long been used as a warning color on marker buoys and signs.

Form and Materials

Aquaculture facilities which borrow from structures and forms already in the marine environment can minimize visual impact. Buoys, pilings, docks, and marinas are commonplace on many Puget Sound waters. The Boston Harbor rendering and the National Marine Fisheries operation at Manchester, on the Kitsap Peninsula, are incorporated into existing dock or marina facilities. In this context, the vertical element of sheds and buildings are visually compatible with the setting. Similarly, oyster stake cultures could repeat the many examples of remnant pilings from docks, buildings, and railroad trestles.

Most aquaculture facilities are visually evident and obviously manmade. In general, those with some degree of order and simplicity are positive forms. Those without order and chaotic in arrangement and type of materials have a more negative visual impact. Other variations of shape and configuration don't seem to have a significant effect on visual impact.

Alignment has only a slight effect on visual impact. Aligning rows of salmon pens perpendicular to the shoreline, instead of parallel to the shore, presents less visible structure. But only when the viewer is directly perpendicular to the rows is open water evident. When viewed from an angle, particularly from a low bank, the rows coalesce and the channels tend to disappear.

Mitigating Measures

Depending on the level of visual impact (as well as other impacts such as biological, navigational, or shoreline access), governmental agencies may require mitigating measures as a condition of project approval.

The analysis of visual impact indicates two categories of mitigation measures for proposed aquaculture facilities: alternate site selection, and modification of site layout and facility design. All are inter-related and dependent on each other. None are absolute. Each agency would have to apply them to site-specific locations. Most apply to site locations within one-third of a mile of the shoreline. They range from general to specific.
ALTERNATE SITE SELECTION OPTIONS

1. Identify and select those sites with the capacity to accept human alteration. Avoid sites which have been identified as unique natural environments.

2. Identify and select those sites adjacent to rural or low density development. Avoid sites offshore of existing suburban residential developments.

3. Identify and select sites adjacent to existing commercial/industrial maritime activity, when compatible with the water quality requirements of aquaculture.

4. Identify and select those sites not visible or with limited visibility from adjacent high use transportation routes and public use areas.

5. Identify and select embayments larger than one mile across. Avoid small, enclosed embayments less than one mile across (unless there is limited adjacent residential development, travel routes, or use areas).

6. Identify and select those sites with adjacent low bank shorelines. Avoid sites with adjacent high bank shorelines (must be coordinated with distance offshore).

SITE LAYOUT AND FACILITY DESIGN OPTIONS

1. Locate, when feasible, 1,500 to 2,000 feet offshore. Distance dependent on height above sea level of key observation points.

2. Limit facility shape to horizontal forms. Discourage vertical forms such as worksheds and buildings (unless incorporated as part of dock or marina).

3. Incorporate as part of existing docks or marinas, or design to appear as boat dock, when feasible with use patterns and water quality.

4. Limit overall size and surface coverage of projects. Dependent on the degree of foreshortening created by distance offshore and height of observer position above sea level (see "Visual Impact" section discussion of facility location and design).

5. Select colors which complement or are natural to the dominant blue/green colors of the Puget Sound.

6. Require ordered design with limited variation in materials and colors.
Visual Assessment Workbook

The Visual Assessment Workbook provides an analytical process for evaluating proposed aquaculture facilities. Regional planning agencies can use it to identify and evaluate those Puget Sound environments least (or most) susceptible to visual impact. Local planning agencies can incorporate it into their project review process. It is a general guide. Each local planning agency can modify the descriptions and rating scores to reflect local conditions, values and preferences.

The workbook adopts visual assessment techniques to Puget Sound sites and aquaculture facilities. It borrows from techniques developed by two Federal agencies -- the Bureau of Land Management (BLM) and the U.S. Forest Service (U.S.F.S.).

The U.S.F.S. identifies nine basic assumptions related to visual quality that can be used in assessing aquaculture visual impact. They include:

- People have certain scenic expectations;
- View duration is critical;
- Number of viewers is critical;
- Diversity increases scenic value;
- Retention of distinctive character is desirable;
- Each setting varies in capacity to absorb visual alteration;
- Landmarks/focal points receive critical scrutiny;
- Viewing angle is critical; and
- Viewing distance is critical.

The B.L.M. identifies three basic principles concerning visual quality that can be adopted for use in assessing aquaculture visual impact. They include:

- Landscape character is primarily determined by the four basic visual elements of form, line, color, texture. Although all four elements are present in every landscape, they exert varying degrees of influence.
- The stronger the influence exerted by these elements, the more interesting the landscape.
- The more visual variety in a landscape, the more aesthetically pleasing the landscape. Variety without harmony, however, is

4 USDA, USFS, p. 2-4
unattractive, particularly in terms of alterations (cultural modifications) that are made without care.

Methodology

The methodology has an inventory and an analysis component. The three inventory categories are scenic quality, sensitivity level, and visibility. The analysis component synthesizes these categories into four levels of visual impact.

Inventory

The inventory of scenic quality rates the basic visual elements of the water body and the surrounding landforms. Its three variables are environmental condition, spatial definition, and adjacent scenery. The individual rating scores are compiled to determine high, moderate and low scenic quality.

The inventory of sensitivity level measures the number of potential viewers and the duration of view as high, moderate or low.

Visibility identifies key observation points and evaluates the effect of view obstruction, distance offshore/observer position, and viewshed coverage. The individual rating scores are compiled to determine high, moderate and low visibility.

Analysis

The analysis component synthesizes the inventory data into four visual impact classes.

Class I areas include the federally designated San Juan Wilderness Areas (84 rocks, reefs, grassy and forested islands). This is an area where the earth and its community of life are untrammeled by man, where man is a visitor and does not remain. It shall be managed to retain its primeval character. Permanently visible aquaculture projects are prohibited.

In Class II areas, permanently visible aquaculture facilities will be visually obtrusive and have a high visual impact. Mitigation measures will be necessary.

In Class III areas, permanently visible aquaculture facilities will be visually evident and have a moderate visual impact. Mitigation measures may be necessary.

In Class IV areas, permanently visible aquaculture facilities will have little adverse visual impact. Few, if any, mitigation measures are necessary.

5 USDI, BLM, p. 13
AQUACULTURE VISUAL IMPACT ANALYSIS
Approach and Methodology for Analysis & Review of Project Proposals

This work book provides an analytic process for evaluating proposed aquaculture facilities. It contains an inventory & analysis component, described below:

**STEP ONE**
Inventory project site for determination of Scenic Quality, Sensitivity Level, & Visibility.

**STEP TWO**
Analysis of project site inventory for determination of four classes of Visual Impact.

**STEP THREE**
Planning officials incorporate the results of Visual Impact analysis with other relevant factors into their permit review process.

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**Visual Assessment Methodology**

<table>
<thead>
<tr>
<th>INVENTORY</th>
<th>ANALYSIS</th>
<th>PROJECT EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenic Quality</td>
<td>Visual Impact Classifications</td>
<td>Approval</td>
</tr>
<tr>
<td>Sensitivity Level</td>
<td></td>
<td>Approval W/ Mitigation Measures</td>
</tr>
<tr>
<td>Visibility</td>
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<td>Disapproval</td>
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</table>
AQUACULTURE VISUAL IMPACT ANALYSIS

Inventory

The inventory portion of this Visual Assessment methodology evaluates three related components of visual impact: Scenic Quality, Sensitivity Level, and Visibility. These rating sheets provide a format for the inventory & evaluation of each component and subcategory.

Inventory Process

**SCENIC QUALITY**
- Environmental Condition
- Spatial Definition
- Adjacent Scenery
  - High
  - Mod
  - Low

**SENSITIVITY LEVEL**
- Number of Viewers
  - View Duration
- High
  - Mod
  - Low

**VISIBILITY**
- View Obstruction
  - Distance
  - Offshore/Observer Position
  - High
  - Mod
  - Low
- Viewshed Coverage
AQUACULTURE VISUAL IMPACT ANALYSIS
INVENTORY AND EVALUATION RATING SHEET

Project Name ___________________________
Project Location _______________________

COMPONENT: Scenic Quality
SUB-CATEGORY: Environmental Condition
DESCRIPTION: Capacity of landscape to accept Human Alteration without losing its natural Visual Character.

TASK: choose category which corresponds to project site.

<table>
<thead>
<tr>
<th>Visual Attributes</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>Areas of exceptional natural landscape character or habitat, or areas set aside by law to be preserved in a natural state. (Wilderness areas, National Wildlife Areas or Sanctuaries, State Habitat Management Areas, i.e., wilderness islands of the San Juans, Nisqually, Padilla Bay, or Skagit Bay).</td>
<td>1</td>
</tr>
<tr>
<td>MODERATE</td>
<td>Distinctive landscape character, public parks or use areas (views of forests and snow capped mountains; Logaboo and Camano Island st. Park); or areas with visible evidence of human activity, but not at a dominating level. (Residential development, docks, or piers).</td>
<td>0</td>
</tr>
<tr>
<td>LOW</td>
<td>Areas w/human modification so extensive that natural scenic qualities are nearly eliminated or substantially reduced (Industrial Harbors, oil refineries; i.e. Fidalgo Industrial Area).</td>
<td>-1</td>
</tr>
</tbody>
</table>
QUACULTURE VISUAL IMPACT ANALYSIS

Project Name ____________________
Project Location __________________

COMPONENT: Scenic Quality
CATEGORY: Spatial Definition
DESCRIPTION: Degree of spatial enclosure and volume created by the near plane of the water body and the surrounding landforms.

Please choose category which responds to project site:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH</strong> Concave embayments, less than ½ mile across (Gig Harbor, Port Ludlow, Upper Quartermaster Harbor, Inner Port Madison).</td>
<td>1</td>
</tr>
<tr>
<td><strong>MODERATE</strong> Concave embayments, ½ mile to 2 miles across (Outer Port Madison); or open shoreline where far-shore is less than two miles away (Hood Canal, Budd Inlet).</td>
<td>0</td>
</tr>
<tr>
<td><strong>LOW</strong> Open shoreline where far-shore is greater than 2 miles away (Carr Inlet, Skagit Bay).</td>
<td>-1</td>
</tr>
</tbody>
</table>
# AQUACULTURE VISUAL IMPACT ANALYSIS

## INVENTORY AND EVALUATION RATING SHEET

**Project Name**

**Project Location**

**Component:** Scenic Quality

**Sub-Category:** Adjacent Scenery

**Description:** Adjacent shoreline, edge, landform, and vegetation which define the embayment. Influence, detail, and clarity diminish with distance. In general, impact of this variable increases as the degree of enclosure increases or as the embayment size or the distance to the opposite shoreline decreases.

**Task:** Choose category which corresponds to project site.

<table>
<thead>
<tr>
<th>Visual Attributes</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td>Rich combinations of form, line, color, &amp; texture. Views of snow-capped peaks; adjacent slopes &gt; 60% slope, irregular surface, exposed rock outcrops, exposed cliffs; Diverse vegetation w/ high degree of pattern &amp; texture. Generally, most influential within 1/4 mile of key viewing points.</td>
<td>1</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>Some variety of form, line, color, &amp; texture. Adjacent landforms 30-60%, moderate surface variation, limited rock outcrops or exposed cliffs; mature vegetation. But generally continuous pattern; or adjacent scenery 1/4 to 1 mile away.</td>
<td>0</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>Little or no variety of form, line, color, &amp; texture. Slopes &lt; 30%, little or no surface variation, no rock outcrops or exposed banks; continuous vegetative pattern w/ little or no pattern; or adjacent scenery &gt; 1 mile away.</td>
<td>-1</td>
</tr>
</tbody>
</table>
QUACULTURE VISUAL IMPACT ANALYSIS
INVENTORY AND EVALUATION RATING SHEET

Project Name____________________________________
Project Location__________________________________

COMPONENT: Scenic Quality Summary

DESCRIPTION: Evaluation of individual scenic quality factors to determine overall site scenic quality.

Total values for each scenic quality factor and select one of the following classifications:

HIGH - Areas that combine the most outstanding characteristics of each rating factor (2 or 3 points).

MODERATE - Areas with a combination of some outstanding features and some that are fairly common (-1, 0, or 1 points).

LOW - Areas with features that are fairly common (-2 or -3 points).
AQUACULTURE VISUAL IMPACT ANALYSIS
INVENTORY AND EVALUATION RATING SHEET

Project Name __________________________________________
Project Location _______________________________________

COMPONENT: Sensitivity Level

DESCRIPTION: Number of potential viewers, related to adjacent travel routes, use areas, or existing residential development.

TASK: Choose category which corresponds to project site.

Visual Attributes  Description

HIGH
Water bodies where the potential number of viewers is high, and the opportunity exists for sustained views (shorelines with adjacent viewpoints, park and recreation sites), resorts, high density residential development.

MODERATE
Water bodies where the potential number of viewers is moderate, or the view duration is only a quick glance. Shorelines with adjacent travel routes or low to moderate density residential development.

LOW
Water bodies where the potential number of viewers is low. Shorelines with few adjacent travel routes, use areas, or very low density residential development.
Project Name

Project Location

COMPONENT: Visibility

C-CATEGORY: View Obstruction

DESCRIPTION: Degree of obstruction in viewing the water by vegetation, landform, or man-made objects.

ASK: Choose category which corresponds to project site.

Visual Attributes

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN VIEW</td>
<td>1</td>
</tr>
<tr>
<td>PARTIALLY OBSTRUCTED VIEW</td>
<td>0</td>
</tr>
<tr>
<td>OBSTRUCTED VIEW</td>
<td>-1</td>
</tr>
</tbody>
</table>

OPEN VIEW
No view obstruction from key viewing points.

PARTIALLY OBSTRUCTED VIEW
Some view obstruction from key viewing points.

OBSTRUCTED VIEW
No key viewing points or all views of water obstructed by vegetation, landform, or man-made objects.
AQUACULTURE VISUAL IMPACT ANALYSIS
INVENTORY AND EVALUATION RATING SHEET

Project Name ____________________________
Project Location __________________________

COMPONENT: Visibility
SUB-CATEGORY: Distance Offshore/Observer Position
DESCRIPTION: Visibility critically related to distance offshore and height of key observation points above sea level. Influence, detail, clarity, and scale diminishes as distance offshore increases. Foreshortening and scale diminishes the nearer the observer position is to sea level.

TASK: Choose category which corresponds to project site.

<table>
<thead>
<tr>
<th>Visual Attributes</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGH</td>
<td>2-300 ft. offshore, 15 ft. above sea level</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0-750 ft. offshore, 30 ft. above sea level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0-750 ft. offshore, 55 ft. above sea level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300-750 ft. offshore, 105 ft. above sea level</td>
<td></td>
</tr>
<tr>
<td>MODERATE</td>
<td>750-1,500 ft. offshore, 30 ft. above sea level</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>750-1,500 ft. offshore, 55 ft. above sea level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>750-2,000 ft. offshore, 105 ft. above sea level</td>
<td></td>
</tr>
<tr>
<td>LOW</td>
<td>&gt;300 ft. offshore, 15 ft. above sea level</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>0-300 ft. offshore, 105 ft. above sea level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,500 ft. offshore, 5-55 ft. above sea level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;2,000 ft. offshore, 105 ft. above sea level</td>
<td></td>
</tr>
</tbody>
</table>
QUACULTURE VISUAL IMPACT ANALYSIS
INVENTORY AND EVALUATION RATING SHEET

Project Name

Project Location

COMPONENT: Visibility
CATEGORY: Viewshed Coverage
DESCRIPTION: Percentage of normal cone of vision occupied by proposed aquaculture facility. Requires project sets & photographs taken with normal lens (50 mm for a 35 mm camera), or computer simulations at offshore.

Choose category which corresponds to project site.

<table>
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</thead>
<tbody>
<tr>
<td><strong>HIGH</strong></td>
<td>Project covers &gt;10% of cone of vision as viewed from 75% of key observation points.</td>
<td>1</td>
</tr>
<tr>
<td><strong>MODERATE</strong></td>
<td>Project covers 5-10% of cone of vision as viewed from 25-75% of key observation points; or covers 5-10% of cone of vision as viewed from 75% of key observation points.</td>
<td>0</td>
</tr>
<tr>
<td><strong>LOW</strong></td>
<td>Project covers &lt;5% of cone of vision as viewed from key observation points.</td>
<td>-1</td>
</tr>
</tbody>
</table>
AQUACULTURE VISUAL IMPACT ANALYSIS
INVENTORY AND EVALUATION RATING SHEET

Project Name

Project Location

COMPONENT: Visibility Summary

DESCRIPTION: Evaluation of individual visibility factors to determine overall visibility.

TASK: Total values for each visibility factor and select one of the following classifications.

Description

HIGH
Areas that combine most of the highly visible attributes of each rating factor (2 or 3 points).

MODERATE
Areas with a combination of some of the highly visible and less visible attributes of each rating factor (-1, 0 or 1 point).

LOW
Areas with little or no visibility (-2 or -3 points).
ANALYSIS OF VISUAL IMPACT

DESCRIPTION: Determination of four levels of visual impact through the synthesis of Scenic Quality, Sensitivity Level, and Visibility.

ASK: Use the diagram and matrix below to determine the extent of probable visual impact at the project site. Refer to the class descriptions for the level of visual impact and suggested mitigation measures.

Analysis Process

<table>
<thead>
<tr>
<th>INVENTORY</th>
</tr>
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<tbody>
<tr>
<td>Scenic Quality</td>
</tr>
<tr>
<td>Sensitivity Level</td>
</tr>
<tr>
<td>Visibility</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLASS I - Wilderness Areas</td>
</tr>
<tr>
<td>CLASS II - High Visual Impact</td>
</tr>
<tr>
<td>CLASS III - Moderate Visual Impact</td>
</tr>
<tr>
<td>CLASS IV - Low Visual Impact</td>
</tr>
</tbody>
</table>
**AQUACULTURE VISUAL IMPACT ANALYSIS**

<table>
<thead>
<tr>
<th>Scenic Quality</th>
<th>Sensitivity Level/Visibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilderness Areas</td>
<td>I</td>
</tr>
<tr>
<td>High</td>
<td>II</td>
</tr>
<tr>
<td>Moderate</td>
<td>III</td>
</tr>
<tr>
<td>Low</td>
<td>III</td>
</tr>
</tbody>
</table>

**Visual Impact Classifications:**

**Class I (Wilderness Areas) - Severe Visual Impact**

Any permanently visible aquaculture facility will likely have a severe visual impact that cannot be mitigated.

**Class II - High Visual Impact**

Areas where permanently visible aquaculture facilities will likely be visually obtrusive. To mitigate impact, project scale should be small enough not to draw attention to itself or be located so not to be visually evident from key viewing points. Project design should borrow from the colors of the natural setting.

**Class III - Moderate Visual Impact**

Areas where permanently visible aquaculture facilities will be visually evident. To mitigate impact, project should remain visually subordinate to the project setting. Project design should borrow from the colors of the natural setting. Scale should be small enough so not to cover more than 15% of the cone of vision as seen from key observation points.

**Class IV - Low Visual Impact**

Areas where existing visual disruptions dominate (industrial landscapes) or areas of low sensitivity/visibility. Most aquaculture facilities are unlikely to have an adverse visual effect. Few, if any, mitigation measures are necessary.