VALUE ENGINEERING WORKSHOP REPORT

CITY OF LONGVIEW, WASHINGTON

WATER SUPPLY ALTERNATIVES

SMITH·CULP CONSULTING

September 4, 2007

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INTRODUCTION

The City of Longview currently has a 60-year old surface water treatment plant that draws raw water from the Cowlitz River. Sediment resulting from the 1980 eruption of Mt. Saint Helens has flowed down the river to Longview and has caused operational problems at the existing river intake and in the treatment plant. The October 2006 report "City Of Longview Source Analysis" by PACE Engineers compared the alternative of improving the river intake and rehabilitating the existing surface water treatment plant with an alternative involving new wells and a groundwater treatment plant using a membrane microfiltration process to remove iron, manganese and arsenic from the groundwater. Both alternatives were designed to provide a treatment capacity of 20 million gallons per day (mgd). The report proposed that the wells and the groundwater treatment plant be located at the Mint Farm Industrial Park. The purpose of the Value Engineering (VE) workshop was to review the previous analysis of alternatives and develop and evaluate potential options.

This report presents the results of the VE workshop held August 27-30, 2007 in Longview, Washington. This VE study was conducted based on the October 2006 report and other related documents provided by the City of Longview. The VE workshop was conducted by a four-person team and a team coordinator (see Appendix C for team members). The VE study was conducted in five phases: information, speculation, evaluation, investigation, and recommendation. Each of these phases is described below.

INFORMATION PHASE

Prior to the workshop, the documents provided by the City were reviewed by the team. On Monday morning, August 27, the first session of the workshop was devoted to information collection. A presentation was made by the Jeff Cameron, City of Longview, and Patrick O'Brien, U.S. Army Corps of Engineers. The following attended the first session:

Gordon Culp, Smith Culp Consulting, VE Team Coordinator
George Mack Wesner, Consulting Engineer, VE Team
Greg Sindt, Bolton and Menk Consulting Engineers, VE Team
Bob Mussetter, Mussetter Engineering, VE Team
Sigurd Hansen, SPH Associates, VE Team
Patrick O'Brien, U.S. Army Corps of Engineers
Russ Lawrence, PACE Engineers
Susan Boyd, PACE Engineers
Ray Johnson, Cowlitz PUD
Craig Bozarth, City of Longview
Mike Piechowski, Robinson, Noble and Saltbush
Amy Blain, City of Longview
Ric Saavedra, City of Longview
Jeff Cameron, City of Longview

Following the presentation, the VE team toured the existing surface water treatment plant and the proposed site of the groundwater treatment plant.

At the conclusion of the workshop, an informal presentation of the preliminary results of the VE workshop was presented. This presentation was attended by:

Gordon Culp, Smith Culp Consulting, VE Team Coordinator
George Mack Wesner, VE Team
Greg Sindt, Bolton and Menk Consulting Engineers, VE Team
Sigurd Hansen, SPH Associates, VE Team
Patrick O'Brien, U.S. Army Corps of Engineers
Susan Boyd, PACE Engineers
Craig Bozarth, City of Longview
Amy Blain, City of Longview
Ric Saavedra, City of Longview
Jeff Cameron, City of Longview
Teresa Walker, Washington State Department of Health
Kim Anderson, Beacon Hill Sanitation District
Ramona Leber, Longview City Council
Mary Jane Meliak, Longview City Council
Dave Campbell, City of Longview
Don Jensen, Longview City Council
Kurt Anagostou, Longview City Council, Mayor pro tem

Review of River Sediment Issues

A required condition for the option of rehabilitating the existing surface water treatment plant for long-term use is the ability to address issues related to the heavy and varying sediment load in the Cowlitz River. Thus the VE team undertook a review of information related to the river sediment issues.

The City of Longview's existing raw water intake, which was constructed in 1960, was designed to operate at a low water level of 0.8 feet msl. The intake is located on the right (west) bank of the Cowlitz River about 5.2 miles upstream from the mouth. The bed of the river has aggraded significantly in response to high sediment loads associated with the 1980 eruption of Mount St. Helens. As a result of this aggradation, a significant amount of sediment now enters the intake and is pumped to the water treatment plant, taxing the raw water pumps and solids handling equipment. In 1996, the average bed elevation in the vicinity of the intake was at approximately 1-foot msl (Figure 1). Based on a survey performed in August 2007, the average bed elevation is currently in the range of 8.5 to 9 feet msl, and the thalweg (minimum bed elevation) is at about 7 feet msl at both the intake and along the bank on the opposite side of the river (Figure 2). The lower elevation in the immediate vicinity of the intake is due, in large part, to recent small-scale dredging conducted for the City. Sand is currently moving down the river in waves of unknown height that could temporarily raise the bed at the intake above the existing levels. These sand waves have the potential to isolate the intake from the river flow. In addition, suspended sand during high winter flows apparently is drawn into the intake, which also can over-tax the solids handling equipment. A key question in assessing potential options for mitigating the sedimentation problems at the intake is the extent to which the river will continue to aggrade at this location. As will be described below, the available information indicates that the amount of additional aggradation will most likely be limited; thus, the problems that have recently been experienced should not significantly worsen.

A cross section near the mouth of the river that was surveyed in August 2003, April 2006 and December 2006 has been included in several recent City and Corps presentations indicating that the late-2006 flood event caused significant additional aggradation (Figure 3). This cross section changed very little between August 2003 and April 2006, but the thalweg raised by over 10 feet and significant net aggradation occurred over much of the remainder of the cross section between the April and December 2006 surveys. The changes at this location, however, are not representative of changes farther upstream, including the vicinity of the raw water intake. The average bed elevation at River Station (RS) 5.01, just downstream from the intake, and at RS5.5, about 0.3 miles upstream from intake, for example, changed very little between the 2004 and December 2006 surveys (Figures 4 and 5). Comparison of the thalweg profiles between the 2004 and 2006 surveys also indicates that the reach between about 0.5 miles upstream from the mouth and a few miles upstream from the intake did not systematically aggrade during this time period (Figure 6).

Based on computer modeling of the river's response to the anticipated sediment loads from the Mount St. Helens eruption, the Portland District Corps (2002) predicted that the bed would aggrade to an average elevation of 9 to 10 feet msl by 2034, only slightly above the observed levels since 2004 (Figure 1). The Corps (2002) modeling also indicated that the rate of aggradation will decline over time as the river approaches a state of dynamic equilibrium with the upstream sediment supply (Figure 7). Although the Corps (2002) modeling under-predicted the rate of aggradation, it should be capable of predicting the equilibrium bed profile, because the model estimates bed changes based on a comparison of the upstream sediment supply with sediment transport capacity at each cross section that is computed based on the local hydraulic conditions and bed material size gradation. Hydraulic conditions in the downstream portion of the Cowlitz River are controlled by the water-surface elevations in the Columbia River. Continued dredging of the Columbia River navigation channel will most likely maintain the hydraulic control at the mouth of the Cowlitz River at or below its current level for the foreseeable future. The Corps is also planning to dredge about 3.5 mcy of material from the lower 2.5 miles of the Cowlitz River over the next two years, and they plan to perform additional dredging over the next 5 years to maintain the target bed elevations (Patrick O'Brien, personal communication, 2007). The proposed dredging will lower the bed by 12 to 13 feet at and downstream from RS2.5. The Corps believes this bed lowering will propagate upstream, which would lower the bed elevation in the vicinity of the City's intake. Whether the amount of bed lowering upstream from the dredge area associated with this process will be significant is debatable, but at worst, when coupled with the apparently stable downstream hydraulic control, it should prevent additional systematic aggradation in the vicinity of the intake. As a result, the average bed elevation in the vicinity of the intake should not increase significantly for the foreseeable future. Movement of sand waves may, however, cause temporary increases of a few feet in the vicinity of the intake that could exacerbate problems with the intake capacity and excess solids loading to the plant. In fact, these waves have the potential to isolate the intake from the river during low flow periods.

The Corps is reportedly planning to do additional computer modeling to update their estimates of the sediment supply to the river, and to assess the likely future response of the river. This modeling should provide additional information to assess the above conclusions.

In summary, based on the available information, significant additional aggradation in the vicinity of the City's raw water intake does not appear to be likely due to the combined effects of the hydraulic control on water-surface elevations in the provided by the Columbia River and the ongoing and planned dredging in both the Columbia River navigation channel and the downstream 2.5 miles of the Cowlitz River. As a result, the sedimentation issues that have been experienced at the intake over the past few years are unlikely to worsen. Computer modeling that is being performed by the Corps should provide additional information to assess the validity of this conclusion. Based on the review of information available at the time of the VE workshop and pending further modeling by the Corps, the VE team considered ideas to continue to deal with sediment issues near the intake.

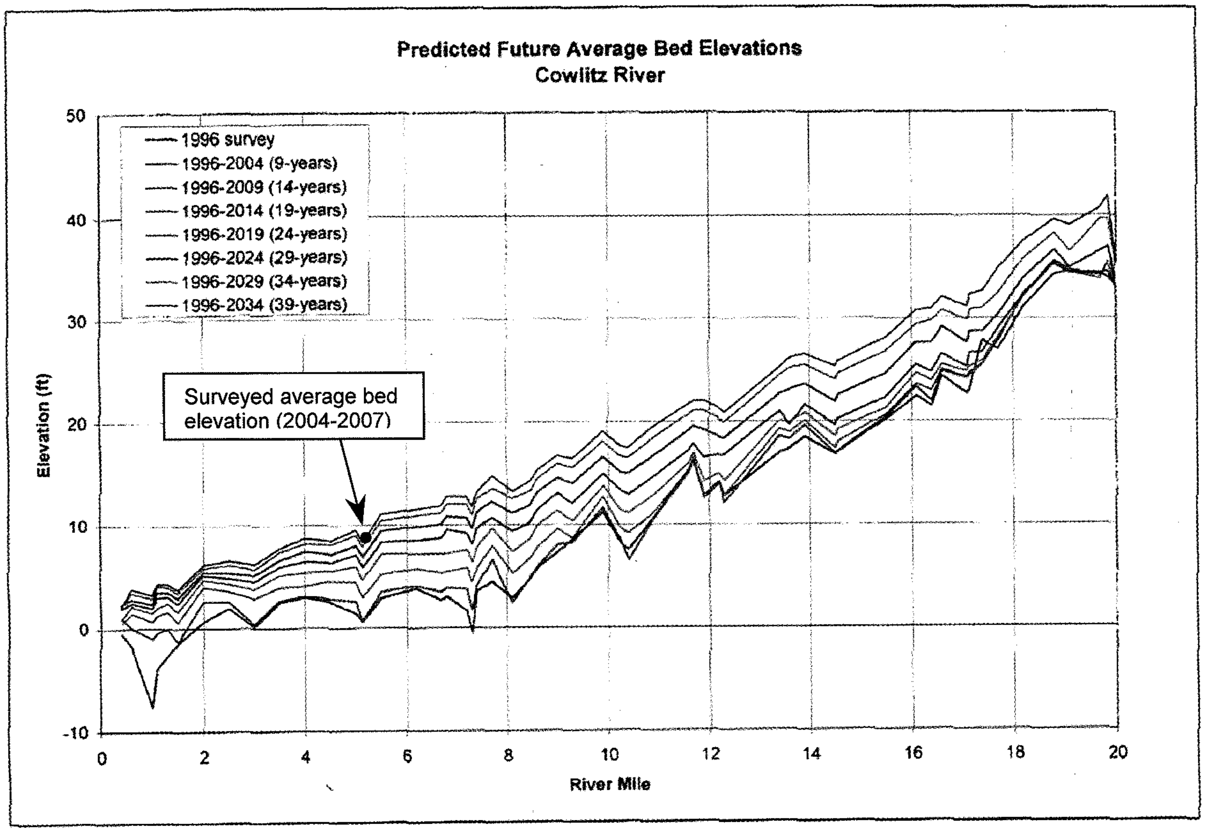

Figure 1. Projected future average bed elevations for the Cowlitz River assuming average future hydrologic conditions (Corps, 2002, Figure 3-26). Also shown is the approximate average bed elevation from surveys conducted in 2004 through 2007.

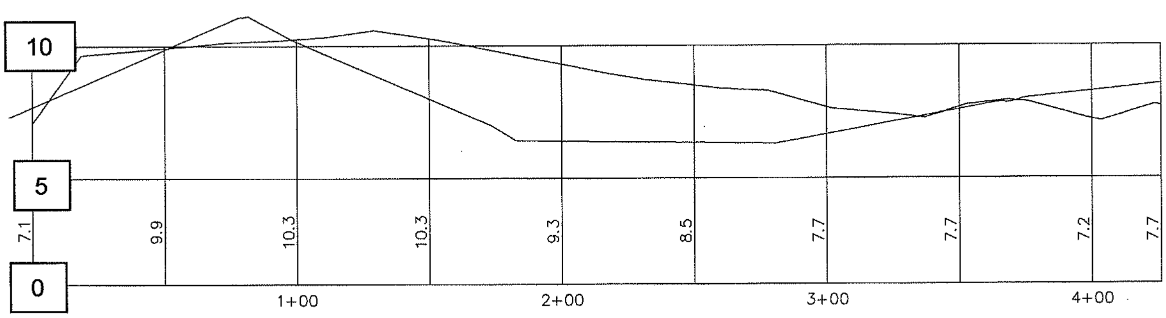

Figure 2. Cowlitz River cross section profiles at the City of Longview raw water intake. (Orange line June 2007; Black line mid-August 2007) (provided by Ric Saavedra, City of Longview)

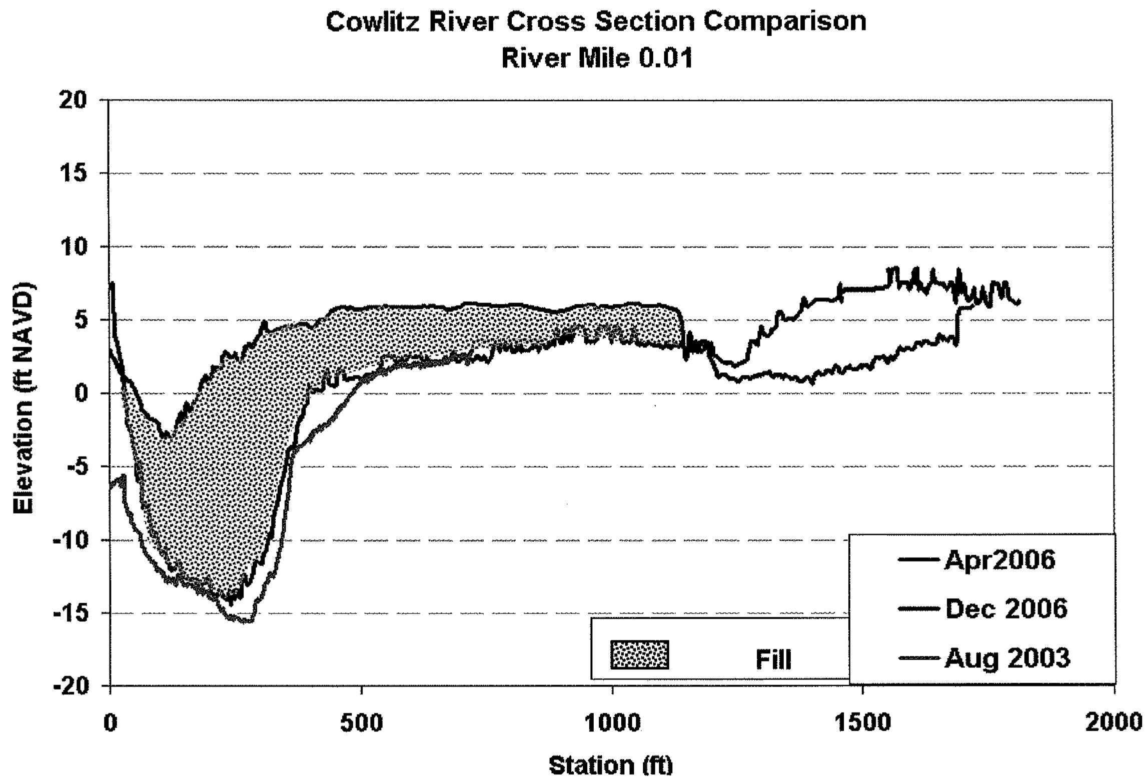

Figure 3. Cross section at RM 0.01 surveyed in August 2003, April 2006 and December 2006 (obtained from PowerPoint presentation by Patrick O'Brien, Corps)

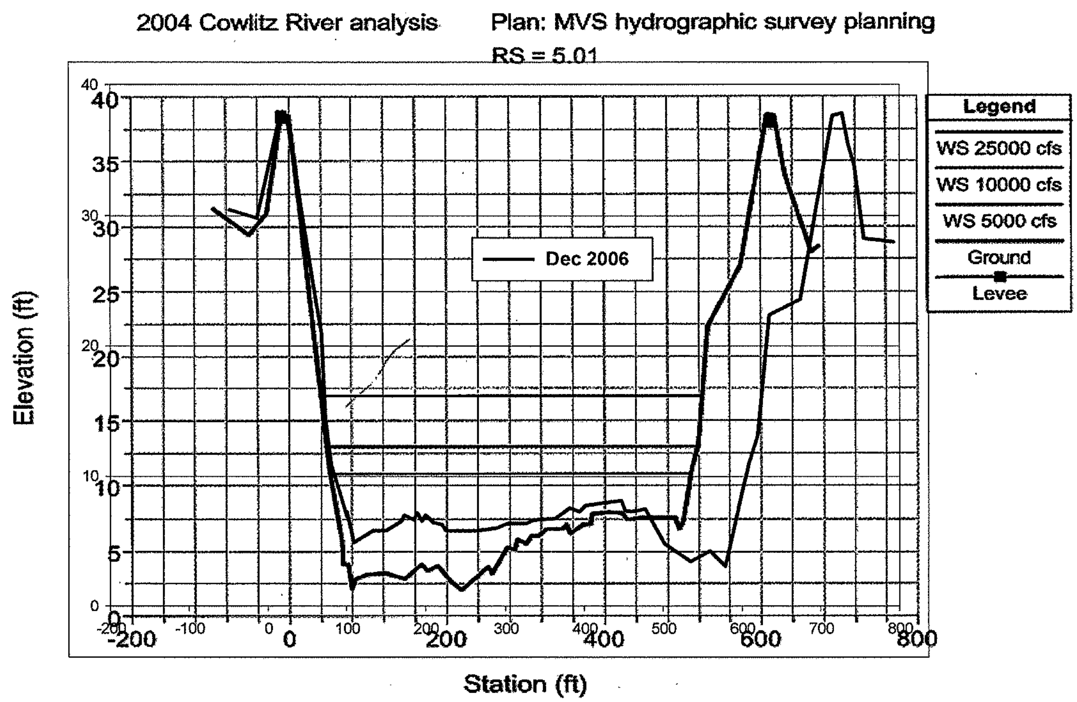

Figure 4. Cross section at RM 5.01 surveyed in 2004 and December 2006. (2004 cross section from O'Brien, et al, 2005; 2006 cross section from HEC-RAS model provided by Patrick O'Brien, Corps, 2007). The reason for the discrepancy in cross section width is not known.

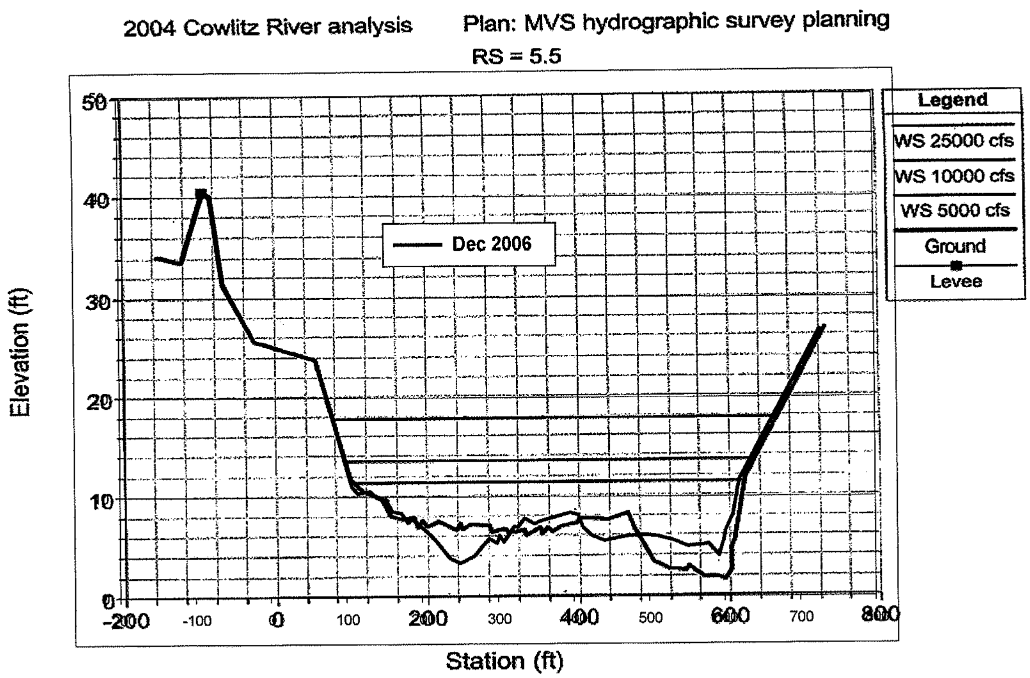

Figure 5. Cross section at RM 5.5 surveyed in 2004 and December 2006. (2004 cross section from O'Brien, et al, 2005; 2006 cross section from HEC-RAS model provided by Patrick O'Brien, Corps, 2007).

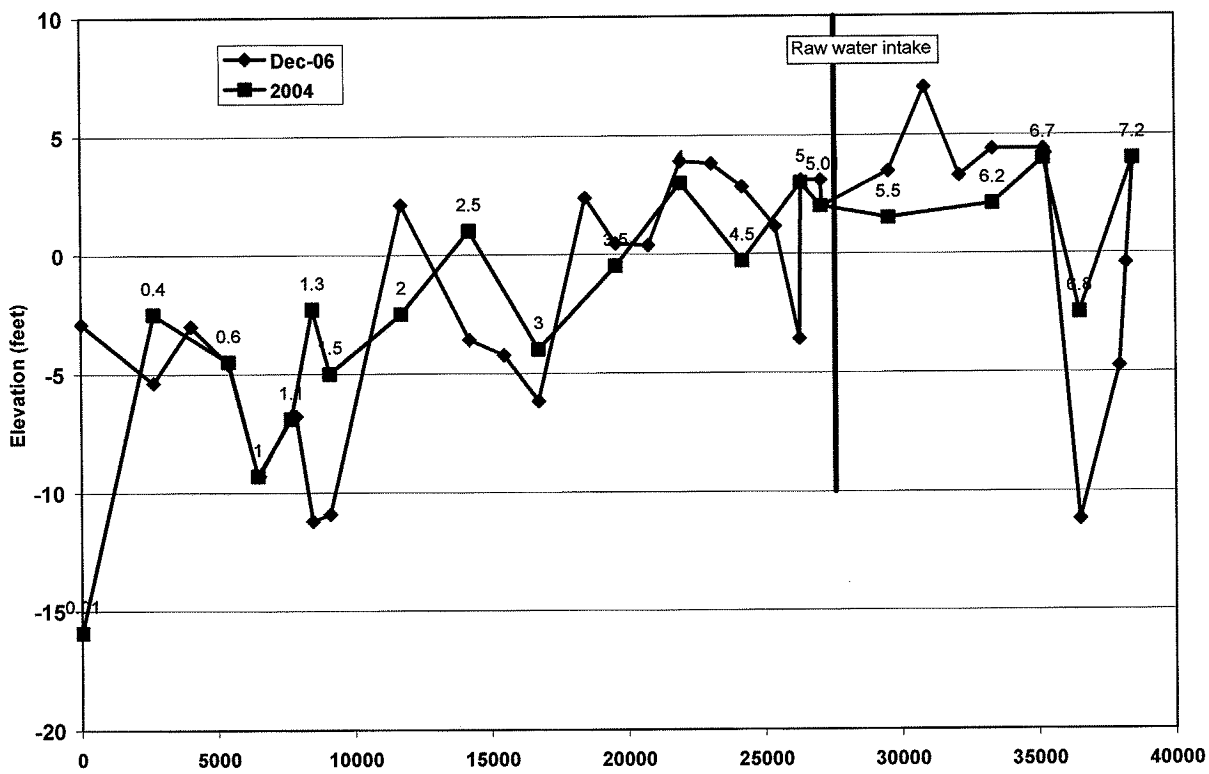

Figure 6. Thalweg (minimum bed elevation) profiles of the downstream approximately 7 miles of the Cowlitz River from data collected in 2004 and December 2006. (2004 data from O'Brien, et al, 2005; 2006 data from HEC-RAS model provided by Patrick O'Brien, Corps, 2007).

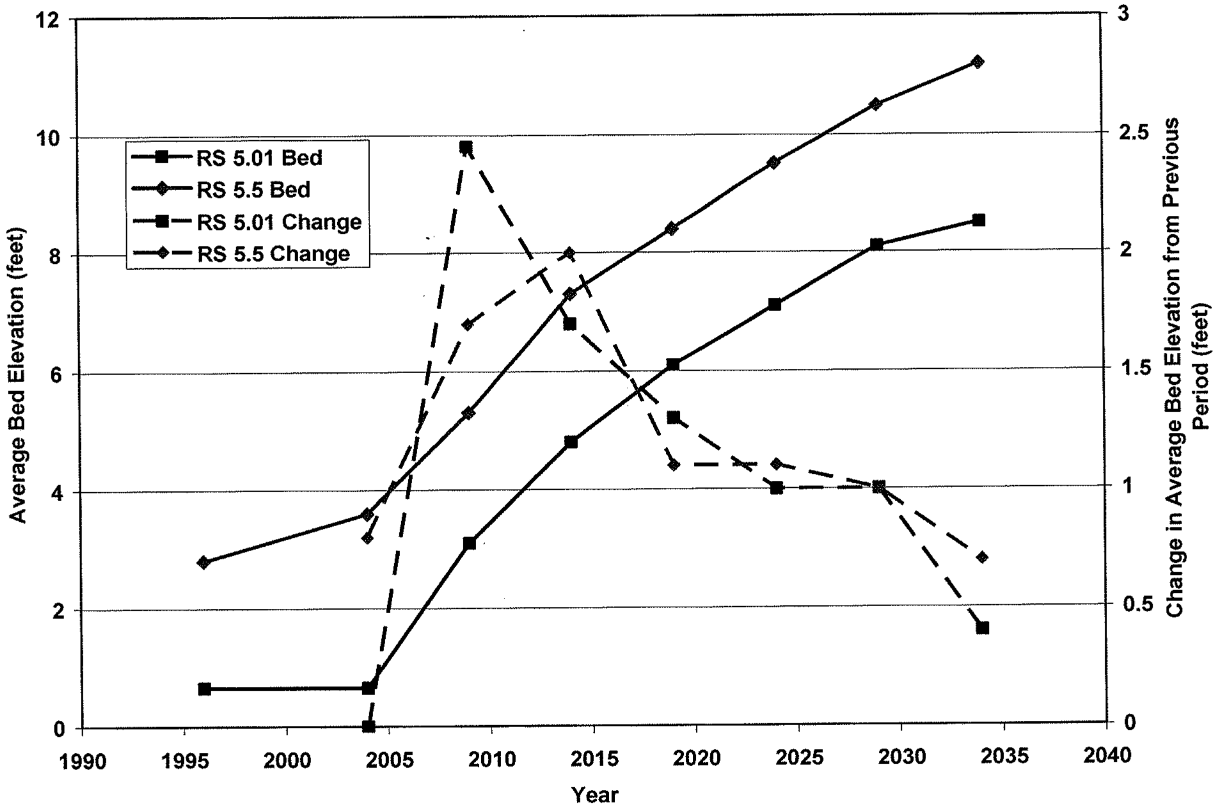

Figure 7. Average bed elevation and change in bed elevation from previous period at RS5.01 and RS5.5 based on Corps (2002) modeling. Data digitized from Figure 1 (Corps 2006, Figure 3-26).

Review of Mint Farm Groundwater Information

The City's hydrogeologist, Michael Piechowski of Robinson, Noble, and Saltbush, Inc., discussed the technical details of the Mint Farm well field with the VE team and provided related reports and data. He and his firm have been involved in the construction and evaluation of wells in the vicinity of the proposed wells, including the 2002 construction of the Mint Farm Generation Station (Mirant) Well No. 2.

Mr. Piechowski's presentation and the January 2007 draft report on the Weber Avenue test well indicate the aquifer has a very large hydraulic capacity. The 6-inch test well was pumped at 260 gpm with less than six feet drawdown. The well water level recovery after test pumping was nearly instantaneous. The calculated aquifer transmissivity is very high (1.03 million gallons per day per foot of aquifer) and is indicative of extremely high hydraulic capacity. The estimated drawdown in the proposed 20-inch production wells operated at 2,000 gpm is less than twenty feet.

The Mirant Corporation wells are located in the same aquifer as the proposed City well field. The Robinson & Noble June 2002 report on the construction and testing of the Mirant Well No. 2 indicates similar very high hydraulic capacity as the City's 2007 test well. The Mirant site has two 12-inch wells with only 246 feet separation distance between the wells. The impact of pumping the new well on the older well was insignificant. The water level dropped only 0.05 feet in the older well when the new well was pumped for 24 hours at 1,236 gallons per minute.

Mr. Piechowski indicated that the aquifer has a very large capacity and is adequate to sustain the projected City and industrial well demands. The available reports and data provide the basis for the hydrogeologist's conclusions.

The reports indicate that a 230 feet thick confining layer overlies the coarse sand and gravel alluvial aquifer. The confining layer consists of alternating layers of low permeability silt and sand. This confining layer protects the aquifer from contamination originating at the ground surface.

The City's hydrogeology consultant reviewed available data, including Environmental Data Resources, Inc. records search of environmental risk management information including governmental agency data bases. Based on this review, the consultant concluded that there is a low risk of aquifer contamination from current and previous industrial activities, but suggested that the City review large industrial facilities that were not identified in the data bases including Solvay Interox, Hubbel, and Reynolds.

The water quality data for the City's test well and the Mirant Well No. 2 indicate generally good water quality. The concentrations of all volatile organic chemicals were below the detection limits in the City's test well. The concentrations of metals and other inorganic parameters, except arsenic, were less than drinking water health based standards.

The arsenic concentration in the City test well was 0.0132 mg/L. The US EPA primary drinking water standard for arsenic is 0.010 mg/L. Arsenic removal will be required. Arsenic can probably be removed with conventional iron and manganese removal processes, but pilot testing is recommended for confirmation.

The iron concentration in the City's test well was 0.97 mg/L, greater than the 0.3 mg/L recommended concentration for acceptable water appearance. The manganese concentration was 0.62 mg/l, greater than the 0.05 mg/L recommended concentration for acceptable water appearance and minimization of manganese staining of plumbing fixtures. Iron and manganese concentrations can usually be reduced to acceptable levels with conventional treatment processes, but pilot testing is recommended for confirmation

The hardness in the City's test well was 116 mg/L expressed as calcium carbonate. The hardness in the current river water supply is in the range of 40 to 50 mg/L. The 116 mg/L hardness is considered adequate and not excessively hard for most water utilities, but Longview customers may observe effects of the increase in hardness with the groundwater source. The harder water will result in increased detergent, soap and shampoo use and a somewhat different feel when bathing with soap.

The reported reactive silica concentration in the Mirant production well is 53.8 mg/L. This concentration is quite high and could impact the iron and manganese removal process. It was also reported ("Draft Construction and Testing Report Weber Avenue Monitoring Well Longview, Washington January 2007", page 4) during the test well pumping that "There was a slight and inconsistent odor of hydrogen sulfide (rotten egg smell) and the water had a slight metallic taste." No tests using formal taste and odor evaluation procedures of the test well water were conducted.

A pilot test should be performed to demonstrate the performance of iron, manganese, arsenic, taste and odor removal processes prior to final process selection and design. Treated well water from pilot treatment operation should be evaluated for taste and odor characteristics using formal test procedures.

The City's test well had fine sand infiltration during the entire test pumping period. Mirant did not experience a problem with fine sand infiltration in its production well. Mr. Piechowski indicated that sand infiltration should not occur with proper well screen and gravel pack design.

In summary, the water quality in the test well is good and should meet current primary drinking water quality standards following treatment for arsenic removal. While the hardness in the well water was not excessive, the increase in hardness as compared with the current river supply may impact customer satisfaction. The date provided by the hydrogeologist indicates that the well supply should be of adequate quantity and protected from contamination from surface sources. The well water supply should be evaluated for taste and odor characteristics. A pilot test should be conducted for evaluation of iron, manganese, and arsenic removal processes and to evaluate the ability of the treatment system to produce finished water with acceptable taste and odor characteristics.

Review of Project Cost Estimates

The VE team developed estimates of the costs of the options defined in the previous study of (1) membrane treatment plant at the Mint Farm site and (2) rehabilitation of the existing surface water treatment plant. The results of the VE team cost estimates are described and compared to the PACE estimates below and in Appendix D. Cost estimates made at the conceptual stage of a project according to accepted cost estimating guidelines are expected to have an accuracy of minus 25% to plus 75%.

As shown in Appendix M of the PACE report, their capital cost estimates include an allowance of 20% for contractor's mobilization, overhead and profit. A contingency allowance of 10, 15 or 20% was then applied by PACE for a total add-on allowance of 1.32-1.44. The amount of contingency varied from item to item. The VE team applied a total add-on allowance of 1.38 so that the VE team cost estimates would be comparable to the PACE estimates. PACE applied their add-on factor to each individual item. The VE team subtotaled the individual items in their estimates and then applied the add-on factor.

The PACE and VE cost estimates are comparable because they include comparable contractor mobilization, overhead and contingency factors. The VE team would normally apply a larger contingency factor than 10-20% at the conceptual design stage. Thus, the cost estimates provide the relative cost of various alternatives but should not be viewed as estimates of the probable construction cost of the projects. Both the PACE and VE team capital cost estimates are of construction costs and do not include costs for items such as engineering, legal, permitting, public involvement, financing, environmental analyses and environmental reports.

Labor costs shown in Table 8 of the October 2006 PACE report for both the Mint Farm and the existing plant options do not include an allowance for fringe benefits and other related labor overhead costs. The City advised the VE team that the direct labor rates should be increased by 100% to reflect total labor costs. The PACE Table 8 personnel cost estimates were adjusted accordingly.

Membrane Plant at the Mint Farm site

The VE team cost estimates are based upon the treatment concept proposed in the PACE reports. The basis for the VE team estimated capital cost of $29.7 million for the membrane plant is shown in Appendix D. The VE team capital cost estimate is about $8 million higher than the PACE estimate. The VE team estimate of O&M cost for the membrane system is also higher than the PACE estimate. The chemical costs shown in Table 8 of the October 2006 PACE report for treatment O&M costs include the costs of chemicals associated with membrane cleaning but do not include the costs of chemicals associated with the oxidation of iron and manganese. The estimated cost of these chemicals based on stoichiometric amounts (chlorine 4 mg/L and potassium permanganate of 2.5 mg/L) required for removal of the iron and manganese concentrations in the water from the test well and to provide some chlorine residual in the finished water is $400,000 per year when treating the 20 mgd rate used in PACE Table 8. These chemical costs were added to the PACE estimate. Membrane replacement costs and other maintenance material costs not included in the PACE estimate were also added. Membrane replacement costs based on 10-year replacement interval were equivalent to an annual cost of $400,000 and were added to the PACE estimate.

Rehabilitation of Existing plant

The VE team does not believe that the air scour facilities for filter backwash are needed and deducted the cost of this item from the PACE estimate of capital costs. It was not clear to the VE team if piping to the new solids handling equipment was included in the estimate. Thus, as described in Appendix D, the adjustments to the estimated cost to rehabilitate the plant were a deduction of $1,231,000 for deleting the air scour and an addition of $110,000 for piping associated with the solids handling equipment for a net reduction of $1,121,000. Other than the labor cost adjustment previously described, the VE team accepted the PACE estimate of O&M costs for the rehabilitated plant.

Detailed estimates should be prepared by the designer and updated as the design proceeds toward completion. The bidding climate at the time the project goes to bid can have a significant effect on the actual cost of the project. Also, the costs of concrete, steel and copper have been extremely volatile in recent months.

SPECULATION PHASE

The team divided the project into several areas for consideration. The team then brainstormed ideas for improved value in these areas. The team generated the ideas listed in Appendix A and the notes to the designer that are shown in Appendix E.

EVALUATION PHASE

The team reviewed each of the ideas for changes from the speculation phase, discussing for each: is construction cost likely to be increased or decreased? Is operating cost likely to be increased or decreased? Is reliability increased or decreased? Is treatment effectiveness likely to be increased or decreased? Are environmental impacts likely to be lessened or worsened? Is constructability likely to be affected? Is the project schedule likely to be affected? After discussion of an item, each team member gave the idea a ranking of 1 to 10 on the desirability of investigating the item further (10 being the most desirable, 1 the least). An average ranking of each item was then noted (see Appendix A). In some cases, it was decided that an item would best be treated as a note to the designer rather than as a change item to be investigated by the team. These notes are found in Appendix E.

INVESTIGATION PHASE

The team conducted more detailed investigations of the ideas with a rating of 7 and above. The individual team member responsible for the evaluation of an idea is shown in Appendix A so that they may be contacted if there are questions about the evaluation of an idea. The results are found in Appendix B. The City and the designer should review other ideas in Appendix A beyond those evaluated in detail by the VE team because these other ideas may stimulate other thoughts for improvement.

DISCUSSION OF VE IDEAS FROM EVALUATION PHASE

Ideas related to the river sediment issues

The VE team identified the following potential options for mitigating the sedimentation issues at the intake:

1. Dredge in the vicinity of the intake.
2. Construct groins or other flow training structures to increase the flow velocity and induce scour in the vicinity of the intake.
3. Expand the wet well at the intake to meet hydraulic capacity.
4. Use directional jets to move sediment away from the intake.
5. Move the intake to the other side of the river.
6. Locate the intake in the river away from the shore.
7. Move the intake to the Columbia River
8. Construct groins or other structures to narrow the river, eliminating the depositional tendencies in the vicinity of the intake.
9. Construct an infiltration gallery in the bed of the river.
10. Use a floating or suspended intake in the river that could adjust to changes in bed and water-surface levels.
11. Use air blowers to move silt away from the intake.
12. Construct a multi-level intake that could be adjusted to changing water-surface and bed levels.

The options that involve placing structures in the river (Items 2, 6, 8, and 10) are technically feasible. A variety of problems associated with implementing these options, however, make them less desirable, and some of the problems may make them infeasible. These problems include public safety issues associated with hazards to navigation and a potential negative impact on flood conveyance capacity. Other issues include the high cost of constructing and maintaining the structures that would most likely be constructed with large rock and/or sheet pile, due to the significant local scour that will occur around them during high flows.

Expanding the existing wet well to increase intake capacity (Item 3) is probably necessary to eliminate problems that have been experienced with the pumps, but this option would not reduce the solids loading to the plant, nor would it mitigate impacts of sediment deposition on the intake capacity.

The use of a directional jet to move sediment away from the intakes (Item 4) could be effective in the short-term. Due to the very limited spatial area that could reasonably be affected by this technique, the effect on the larger problems associated with the aggraded bed, including high solids loading and movement of sand waves that could block the intake, would be relatively small. As a result, this is not considered to be a viable long-term solution.

From a technical perspective, moving the intake to the other side of the river (Item 5) is a viable option. The available historical photography indicates that the main current has typically remained on the left (east) side during low flow periods, most likely due to the mild bend in the river that occurs in this area and the tendency for flow to move to the outside of the bend. As a result, the risk of sand waves blocking an intake located on the left bank appears to be lower than at the existing, right-bank location. The cost of this alternative is, however, quite high, and the risk of sedimentation issues, while lower than at the existing location, still exist. Pace Engineers, Inc. (PACE) estimates that the river crossing would require about 200 feet of trenched piping and about 1,500 feet of piping that would be installed under the river by horizontal boring, at a total cost of about $2.5M. It would also be necessary to acquire the land on which the new intake structure would be constructed, adding to the cost.

Moving the intake to the Columbia River (Option 7) could also be technically feasible; however, there are several potential issues with this option. It would be necessary to transfer the City's existing water right. According to City staff, preliminary contacts with the State indicate that such a transfer would be possible. It would also be necessary to construct a new raw water pipeline from the new intake to the existing plant. Depending on the location of the new intake, this could also make this option relatively expensive. Finally, there could be additional water quality issues associated with radionuclides and other contaminants that are present in the Columbia River, but not in the Cowlitz River.

Infiltration galleries (Item 9) have been attempted in other locations, but these have met with limited success. An infiltration gallery constructed in the Kansas River by the City of Topeka, for example, failed to operate correctly and was abandoned, apparently because scour protection measures that were installed to protect the structure reduced infiltration rates into the gallery to an unacceptably low level. Construction of an infiltration gallery in the Cowlitz River could also be problematic. In general, infiltration galleries are not effective at screening out finer particle sizes that can plug the intake lines. (As a general rule-of-thumb, the slots in the screen should be no larger than half diameter of the smallest particle size.) As a result, the gallery must be installed in a high-permeability gravel pack at sufficient depth below the bed to avoid damage due to bed scour. During high flows, scour associated with the movement of bedforms in the sand bed, combined with local scour around obstructions, could reach depths of 10 feet to 20 feet or more, requiring the burial depth of the gallery to be relatively large to avoid exposure and damage. Due to the amount of fines in the bed material and resulting low permeability, this could severely limit the intake capacity of the gallery.

The use of air blowers to move silt away from the intake (Item 11) could help improve intake capacity during periods when fine sediment build-up restricts flow through the fish screens that will likely be required for any efforts to upgrade the intake. This may be necessary to insure proper functioning of the fish screens, but it will be of little or no value in mitigating the larger problems associated with the aggraded river in the vicinity of the intake.

Raising the intake and/or constructing a multi-level intake that could be adjusted to changing bed and water-surface levels (Item 12) is probably not feasible. Simply raising the intake above the existing level under current conditions is not practical because the intake must continue to operate at low flows. A multi-level inlet is also probably not practical because of the high cost of the fish screens that would be necessary to cover the entire area of the intake.

If the selected alternative is to continue use of an intake in the Cowlitz River at the existing location or across the river, the above information indicates that the best approach to minimizing the risk associated with the sediment problems is to dredge as necessary to insure that an adequate amount of river flow is delivered to the intake to meet input capacity requirements, and to provide the sweeping velocities necessary to prevent debris build-up on the fish screens.

Rehabilitation of the existing intake would require several modifications, including expansion of the opening to accommodate new fish screens that meet National Marine Fisheries Service (NMFS) criteria and expansion of the wet well to eliminate the observed problems with the raw water pumps. Because of the lack of space between the river and West Side Highway, expanding the existing intake may be a problem both in terms of physical expansion of the facility and construction access. While these problems should not be insurmountable, they may make the expansion quite expensive.

NMFS criteria for pump intakes restrict fish screen approach velocities to no more than 0.4 fps. Based on the 20 mgd (31 cfs) intake capacity, the required screen area is, therefore, about 80 ft^2. The most recent estimates by Pace for fish screens at a new intake on the opposite bank from the existing inlet is $5.134M. A similar fish screen installation was constructed for the Whatcom County PUD approximately 6 years ago. This installation consisted of inclined, flat screens with an intake capacity of 33 cfs and the foundation for the screens required pilings because of the sandy soil (Dennis Dorratcague and Mark Hijazi, MWH Global, personal communication). The cost of this installation was about $2.5M, or about $3.2M at today's cost, based on a 4% inflation rate. Considering the shallow water depths and high sediment loads that would need to be accommodated at the City's intake, the PACE estimate is believed to be reasonable, but conservative, and this cost would likely be about the same at the rehabilitated, existing intake or a new intake across the river.

Several equipment options are available for the dredging. Two such options include Mud Cat, which sells both cable-propelled and self-propelled dredges, and Crisafulli, which sells a self-propelled dredge. Information sheets for a cable-propelled Mud Cat dredge and the Crisafulli SD-110 self-propelled dredge that appear to be appropriate for this application, are provided in Appendix F and G. The acquisition cost of the two dredges would be about $250,000 and $180,000, respectively. The capacity of the Mud Cat dredge is about 100 yd^3/hr, and the capacity of the SD-110 is about 85 yd^3/hr. According to the Mud Cat representative, operating costs would be in the range of $10/hr for fuel and incidentals, and maintenance costs typically also average about $10/hr of operating time. The cutter head on both dredges is in the range of 8 feet to 8.5 feet. The depth range of the Mud Cat dredge is about 20 feet and the Crisafulli dredge can operate to depths of about 10 feet, both of which probably exceed the depth requirements for this application. According to the Mud Cat representative, the equipment life is about 20 years if it is properly maintained and operated.

The total present and annualized cost to the City to acquire, operate and maintain the equipment was estimated using the following assumptions:

- Equipment life of 20 years.
- The dredge channel for each dredging event would be about 300 feet, with a width of 16 feet wide (approximately 2 cutter head widths) and depth of 5 feet deep. This would result in a dredge volume of about 3 yd^3/ft of channel length, or about 900 yd^3 total volume per event.
- Based on the dredge capacities, each event would require about 9 to 10 hours to complete.
- Dredging would be required approximately twice per month for 6 months of the year, for a total of 12 dredging events per year.
- Labor to operate and maintain the dredge would include 2 people for the duration of the dredging activity, plus an additional 0.5 person equivalent for maintenance, or about 25 manhours per event.
- Labor cost of $62/manhour.
- Dredge material would be disposed of directly into the river downstream from the intake; thus, disposal costs would be negligible.

Based on the above assumptions, a discount rate of 6%, and including a 25% contingency, the present cost of the dredging would be in the range of $520,000 to $580,000 over the 20-year life, or an annualized cost of about $45,000 to $50,000. A spreadsheet showing the detailed basis for these estimates is provided in Appendix H. Appendix H also includes tables showing the present and annualized cost for dredge channel lengths ranging from 200 feet to 500 feet, and number of dredging events ranging from 1 to 15 times per year.

As noted above, these estimates assume that the dredge material can be disposed of by discharging it directly back into the river downstream from the intake. Although the dredge material would ultimately be carried downstream in the absence of dredging, discharge back into the river may meet with resistance from permitting agencies. If a permit to discharge into the river cannot be obtained, on-shore disposal would be required. Both of the above dredges have the capability to pump the dredge material to an on-shore location in the range of 1,000 to 2,000 feet from the dredge. According to the Mud Cat representative, the cost of the required piping and related equipment for this purpose would be an additional approximately $50,000. The cost of dewatering and disposing of the dredge material after pumping is unknown due to uncertainty in the availability of disposal sites, but it could be substantial.

Summary: Options for reducing the risks associated with the sedimentation problems, while maintaining a surface water-supply to the water treatment plant include the following:

- Rehabilitating the existing intake and periodic dredging to mitigate sedimentation problems,
- Construction of river training structures to increase velocities and induce scour near the intake,
- Moving the intake to the opposite side of the river with periodic dredging, and
- Moving the intake to the Columbia River.

Although technically feasible, river training structures are probably not viable due to a variety of issues including hazards to navigation and potential effects on flood conveyance capacity. Water quality issues associated with radionuclides and other contaminants that are present in the Columbia River, but not in the Cowlitz River, would need to be addressed if an intake in the Columbia River is pursued. The cost of a new intake in the Columbia River and the associated water transmission line could be quite high as well.

Rehabilitation of the existing intake would require expansion of the intake opening to accommodate approximately 80 ft^2 of fish screen to meet NMFS criteria and expansion of the wet well to eliminate problems with the pumps. The Pace cost estimate for fish screens at a new intake on the opposite side of the river of $5.134M appears to be reasonable, but conservative. This cost would likely be applicable to the existing intake, as well. Limited space would likely make the cost of expanding the existing intake facility quite high. Periodic dredging of an approach channel to the existing intake appears to be feasible and relatively inexpensive compared to other options. This dredging would mitigate problems with coarse sediment and insure water delivery to the intake. The dredging would, however, do little to decrease the amount of fine sediment that is delivered to the intake.

Moving the intake to the opposite bank is also technically feasible, and it would reduce but not eliminate the risks associated with sedimentation issues because of its location on the outside of a mild bend in the river where the main current tends to stay during low flow periods. This option is, however, expensive due to the need to construct nearly 1,700 feet of additional piping beneath the river to deliver raw water to the existing treatment plant, and it would not completely eliminate the sedimentation problems nor the likelihood that periodic dredging will be needed. However, a new intake across the river combined with periodic dredging appears to offer the best opportunity to reduce the risks associated with continued use of the river. Subsequent estimates of project costs to rehabilitate and continue to use the existing treatment plant are based on moving the intake to the opposite side of the river as were the cost estimates in the PACE report.

Ideas related to water treatment

Related calculations and work sheets related to these ideas are in Appendix B.

Idea E1. Use gravity grit separation if the existing plant is rehabilitated - A conventional gravity grit separator would be used in this option. This technology has long been used in the water industry, is well proven and is better suited to address the periodic high quantities of grfit found in the raw water at the Longview water treatment plant than the proposed hydrocylcones. The unit could be located in the area of the existing sludge dewatering basins. Even though the costs are greater than the proposed hydrocyclones, getting as much of the heavy grit and sand removed prior to the flocculation and sedimentation processes would significantly reduce maintenance problems in the downstream treatment facilities. This idea should be considered as options are more thoroughly evaluated by the City and its engineers.

Idea E5. Replace existing flocculation/sedimentation with Actiflo clarifiers – Two small Actiflo clarifiers which provide flocculation and very high rate sedimentation could be used to replace the existing flocculators and sedimentation basins in a space smaller than one-half of the area occupied by one existing flocculation/sedimentation basin. The Actiflo clarifiers would eliminate the maintenance problems experienced with the existing units. The costs are substantially higher than the proposed program to repair the existing basins and are also higher than idea E6 (use of high rate DensaDeg clarifiers) that would accomplish the same objectives. It is suggested that the DensaDeg clarifiers (Idea E6) be considered rather than the Actiflo option if use of the existing plant is the selected alternative.

Idea E6. Replace existing flocculation/sedimentation with DensaDeg clarifiers if the existing plant is rehabilitated –Two DensaDeg clarifiers which provide flocculation and very high rate sedimentation could be used to replace the existing flocculators and sedimentation basins in a space smaller than occupied by one existing flocculation/sedimentation basin. The DensaDeg clarifiers would eliminate the maintenance problems experienced with the existing units. Although the costs are higher than the proposed program to repair the existing basins, this idea should be considered as options are more thoroughly evaluated by the City and its engineers.

Idea E11 – Do not add facilities for air scour of filters if the existing plant is rehabilitated. If the plant continues to be used for surface water treatment, the VE team does not believe that air scour is necessary for effective cleaning of the filters considering that polymers are not used as filter aids. Proper surface wash combined with proper backwashing should provide effective filter cleaning. This would provide an estimated savings of $1,230,000.

Idea E16. Separate sedimentation basin sludge from backwash wastewater if the existing plant is rehabilitated – In this option, the filter backwash water would continue to be sent to the existing residuals basins and the sludge from the sedimentation basins would be sent to a new 32-foot diameter thickener located west of the residuals basins. This would avoid placing heavy sludge into the residuals basins and would reduce O&M costs. It would also provide better control of the heavy sludge load to the dewatering basins. Although the costs are higher than the proposed program to modify the residuals basins, this idea should be considered as options are more thoroughly evaluated by the City and its engineers.

Idea E17, Convey well water from Mint Farm site to existing treatment plant and use filter portion of existing plant for treatment – This option involves constructing 19,400 feet of 36-inch pipe to convey the well water from the Mint Farm site to the existing treatment plant where a portion of the plant would be used for treatment. The river intake would no longer be used as a drinking water source. The tube settlers would be removed from the existing sedimentation basins which would be converted to detention tanks to provide reaction time for iron and manganese oxidation using forced draft aeration for oxidation. The PACE cost estimates for portions of the existing plant rehabilitation related to using portions of the plant were used (repair lighting, recoat parking area, repair filters, replace main SCADA system, repair filter effluent manifold, repair pipe gallery, improve backwash piping, replace existing power supply, and construct finished water pipeline). Based upon the VE team's estimate of costs for the Mint Farm membrane facility, this option has the potential to provide significant savings. A new conventional filtration plant at the Mint Farm site (idea N1) appears to also offer significant savings compared to the membrane option and has the advantage of providing an all-new treatment facility. However, the relative costs of these two ideas (E17 and N1) should be the subject of a more thorough evaluation of costs and design considerations by the City and its engineers if the Mint Farm alternative is selected.

Idea E21, Add more clearwell volume to provide more reaction time for disinfection rather than rely on incremental volume in pipe to Hillsdale Reservoir – The current plan calls for a 36-inch pipeline from the treatment plant to the Hillsdale Reservoir. The Kennedy Jenks 2005 report noted that the pipeline would provide added contact time to meet the disinfection contact time requirements. To evaluate the relative economics of providing volume for chlorine contact time in the pipeline, the cost of the incremental volume of a 36-inch and 30-inch pipeline was compared to constructing the same incremental volume in a tank at the treatment plant. The cost of providing the volume in the pipeline was found to be more cost effective and there seems to be little reason to give this idea further consideration.

Idea E22, Provide a new high service pumping facility if the existing plant is rehabilitated – Three new high service pumps would be installed at the east clearwell and the piping between the old pumps and the distribution system would be removed. The new pumps would reduce maintenance and power requirements as well as addressing problems with the poor underground piping at the old lift pumps. Although much of the added capital costs is offset by savings in O&M costs, there is a net increase in present worth costs. However, the potential advantages justify further consideration of this idea as options are more thoroughly evaluated by the City and its engineers.

Idea N1, Construct conventional filtration plant at Mint Farm site rather than a membrane plant – This option involves the construction of a gravity conventional filtration plant at the Mint Farm site rather than a membrane treatment plant. The gravity filtration plant includes 8 filters for 20 mgd with a loading rate of 5 gpm/square foot. Rapid mix and flocculation basins are included. Piling to support the structures is included. The PACE report costs for wells, clearwell and distribution piping are included. The footprint of the plant is somewhat smaller than the footprint of the membrane plant design presented in the PACE report. The estimated capital cost of this idea of $24,979,000 is about $5 million less than the capital cost of the membrane filtration option. The lower O&M cost of this option results in a total present worth savings of $22,700,000. Based upon the VE Team's estimate of costs for the Mint Farm membrane facility, this option has the potential to provide significant savings and should be considered as options are more thoroughly evaluated by the City and its engineers.

Idea N14, Relocate Mint Farm Membrane Plant to Mt. Solo Reservoir site to avoid piling – Construction at the Mint Farm site will involve the use of expensive piling to support treatment plant structures. In this option, the plant would be relocated to the Mt. Solo Reservoir site where piling would not be required. Cost of piping to convey well water to Mt. Solo (36-inch pipe, 10,520 feet) and piping to convey treated water from Mt. Solo to the distribution system (24-inch pipe, 16,220 feet) at a point on 32nd Avenue north of Ocean Beach Highway exceeded the savings realized by eliminating the need for piling. If the new wells could be relocated just to the west of Mt. Solo, the piping costs would be reduced substantially and the cost effectiveness of this option should then be reevaluated.

N20, Phase membrane modules in the Mint Farm plant until demand increases and N21, Phase wells until demand increases – Based on the projected future water demands shown in the Kennedy Jenks 2005 report (Figures 2-1 and 2-2), it would be feasible to defer some components of the plant associated with 5 mgd of the 20 mgd plant and construction of one well for about 10 years for the Mint Farm for either the membrane alternative or the conventional filtration alternative (Idea N1). This would, of course, reduce the initial capital cost. Careful consideration by the City of likely growth scenarios versus the earlier Kennedy Jenks projections is needed to determine the acceptability of this idea.

Idea N24, Use concrete clearwell instead of steel clearwell at Mint Farm plant – The two 130,000 gallon bolted steel tanks would be replaced with one 250,000 gallon buried concrete clearwell. This would provide a more durable, longer lasting structure reducing maintenance costs and eliminating corrosion concerns. Although the initial costs are greater that the proposed steel tanks, the VE team recommends that the idea be considered during design.

RECOMMENDATIONS

Table One summarizes the results of the evaluation of ideas, the associated cost effects and the recommendation of the VE team on whether or not the idea should be considered by the City of Longview and its design team. Often, the designer and owner will modify or create variations of these ideas based on their greater knowledge of the project. The cost estimates in Table One provide an indication of the magnitude of potential cost effects of each idea to assist the owner and designer in deciding which may be worthy of more detailed evaluation.

The savings and cost of ideas summarized in Table One are not additive because some are mutually exclusive.

A summary of the VE team estimates of the relative costs of the system alternatives of the rehabilitation of the existing treatment plant, a membrane plant at the Mint Farm and a conventional filtration plant at the Mint Farm are summarized in Table Two.

If the selected option is rehabilitation of the existing plant, a new intake across the river combined with periodic dredging appears to offer the best opportunity to reduce the risks associated with continued use of the river. A permit for a long-term dredging program should be pursued. The options of purchasing a dredge or contracting for dredging should be evaluated.

If the selected option is the Mint Farm groundwater supply, constructing a conventional filtration plant rather than a membrane plant at the Mint Farm offers the potential for significant savings and should be evaluated further. Conveying well water from the Mint Farm to the existing plant appears to offer savings comparable to a new conventional filtration plant at the Mint Farm site. Subsequent, more detailed evaluation by the City and its engineers will produce a more accurate assessment of costs of system alternatives as well as of the VE ideas for components within the treatment plant options.

The VE team strongly recommends that pilot tests be conducted if the Mint Farm alternative is selected regardless of whether the selected technology is membranes or conventional filtration. A pilot test of at least one-month duration is recommended. The pilot treatment plant equipment can be rented. The VE team also recommends that one of the production wells be drilled to provide the water for the pilot tests. The pilot test should be performed to demonstrate the performance of iron, manganese, arsenic, taste and odor removal processes prior to final process selection and design. Treated well water from pilot treatment operation should be evaluated for taste and odor characteristics using formal test procedures.

NOTES TO DESIGNER

See Appendix E for notes to designer. These are suggestions for the designer to consider in finalizing the design.

Table One
Summary of VE Ideas Evaluated

Number	Description	Estimated Cost Savings ($1000)			Recommended for Consideration
		Capital	O&M/year	Present Worth	
	Intake at Existing Plant				
I1	Dredge as needed	(250.0)	(18.9)	(520.0)	Yes
	Existing Plant Rehabiltation				
E1	Gravity grit separator	(765.0)		(765.0)	Yes
E5	Use Actiflo basins for flocculation/sedimentation	(7,122.0)		(7,122.0)	No
E6	Use DensaDeg clarifiers for flocculation/sedimentaton	(3,051.0)		(3,051.0)	Yes
Ell	Eliminate air scour	1,230.0		1,230.0	Yes
E16	Separate sed basin sludge from filter backwash waste	(141.0)		(141.0)	Yes
E17	Treat water from Mint Farm wells in existing plant	8,255.0	1,336.0	23,218.0	Yes
E21	Expand clearwell, reduce size of pipe to reservoir	(185.0)		(185.0)	No
E22	Provide new high service pumping facility	(360.0)	21.0	(119.0)	Yes
	New Plant at Mint Farm				
N1	Use conventional filtration rather than membranes	4,721.0	1,464.0	22,726.0	Yes
N14	Relocate plant to Mt. Solo to avoid piling	(3,062.0)		(3,062.0)	Yes
N20	Phase membrane modules until demand increases	1,750.0		1,750.0	Yes
N21	Phase wells until demand increases	465.0		465.0	Yes
N24	Install concrete clearwell	(518.0)		(518.0)	Yes

Table Two
Summary Comparison of System Alternatives

	Use Existing Plant Estimated Cost		Membrane Mint Farm Plant Estimated Cost		VE Conventional Filter, Mint Farm
	PACE	VE	PACE	VE	
Initial Capital Cost					
Plant/Distribution	$14,821,000	$13,811,910	$21,453,910	$28,000,000[4]	$23,500,000[5]
Intake	$14,006,680	$14,006,680	x	x	x
PW Future Phase	x	x	x	$1,000,000	$880,000
Annual O&M					
Plant/Distribution	$2,368,840[1]	$2,368,840[1]	$1,800,760[1]	$2,644,760[2]	$1,133,000
Dredging	x	$50,000[3]	x	x	x
Total PW Cost					
Capital	$28,827,680	$27,818,590	$21,453,910	$29,000,000	$24,380,000
O&M	$27,160,000	$27,740,000	$20,600,000	$30,335,000	$13,534,000
TOTAL	$55,988,590	$55,558,590	$42,053,910	$59,335,000	$37,914,000
Advantages	Maintain current water quality Use existing assets Use existing site		Lower O&M costs Modern equipment Dependable supply		Lower capital costs Lower O&M costs Modern equipment Dependable supply
Disadvantages	Unpredictable river effects on supply availability Intake viability uncertain Long term dredging permit feasibility uncertain Use of 60-year old plant for another 20 years Plant requires extensive upgrading		Higher water hardness Potential public perception issues associated with a change to groundwater Potential taste and odor issues		Higher water hardness Potential public perception issues associated with a change to groundwater Potential taste and odor issues

[1] PACE labor costs adjusted to include fringe benefits
[2] PACE O&M costs adjusted to include chemical costs for oxidizing iron and manganese, membrane replacement (10-year interval) and other maintenance material costs
[3] Includes amortized capital cost of purchasing dredge and annual O&M of dredge
[4]VE options at Mint Farm based on building initial phase of 15 mgd capacity and deferring $1.7 million of the total estimated cost of $29.7 million for construction of the 20 mgd capacity until demand increases (demand projections indicate about a 10-year deferral)
[5]Conventional filter costs based on building initial phase of 15 mgd and deferring $1.5 million of the total estimated cost of $25 million for construction of 20 mgd capacity until demand increases (demand projections indicate about a 10-year deferral)

APPENDIX A

VE TEAM IDEAS

IDEA	RATING*	EVAL BY
*NTD= Note to Designer		
Intake (See narrative discussion of these items)		Mussetter
I1-Dredge as needed		
I2-Increase velocity next to intake by channeling flow		
I3-Expand wet well to match hydraulic capacity		
I4-Install directional jets at intake to move sediment away from intake		
I5-Move intake to other side of river (current plan)		
I6-Locate intake away from shore		
I7-Install intake in Columbia River		
I8-Install restriction in river width to increase velocity		
I9-Infiltration gallery in river		
I10-Use floating or suspended intake in river		
I11-Use blowers to move sediment away from intake		
I12-Modify existing intake, raise, provide inlets at higher levels for use in high river flows		
Existing Plant Rehabilitation		
E1- Gravity grit separator	8	Hansen
E2-Eutek grit system (not well suited to high volume of sand, silt experienced at plant)	3	
E3-Pista grit system (not well suited to high volume of sand, silt experienced at plant)	4	
E5-Actiflo basins for sedimentation, abandon existing flocculation and sedimentation basins	8	Hansen
E6-Densadeg basins for sedimentation, abandon existing flocculation and sedimentation basins	8	Wesner
E7-Upflow clarifiers (Ideas E5 and E6 will take less space, less cost)	3	
E8-Retrofit existing sedimentation basins with stainless steel plate settlers (doesn't address ongoing maintenance with flocculation and sedimentation basins)	6	
E9-Install pressure membrane filters (high costs compared to rehab of existing filters)	3	
E10- Use submerged membranes in existing tanks (high costs compared to rehab of existing filters, complex piping)	4	
E11-Eliminate air scour	9	Sindt
E12-Top mounted air scour (air scour not necessary)	2	
E13-Use declining rate filters, eliminate rate controllers (existing system works well)	3	
E14-Use flow proportioning weirs, common influent channel, eliminate rate controllers (existing system works	3	

well)		
E15-Use sodium hydroxide instead of lime for pH adjustment (concerns about loss of calcium passivation of distribution system piping)	4	
E16-Separate sedimentation basin sludge from backwash water, provide waste backwash basin	9	Hansen
E17-Treat water from Mint Farm wells at existing plant	9	Sindt
E18-Treat water from Mint Farm wells at new plant at existing plant site (higher cost than rehab of existing filters)	2	
E19-Use ultraviolet disinfection (higher cost unless necessary to meet THM standards, THM study underway)	3	
E20-Oversize distribution line and remove services to provide needed CT time	Current plan includes	
E21-Expand clearwell instead of oversize distribution line	8	Culp
E22-Provide new high service pumping facility	8	Sindt
New Plant at Mint Farm site		
N1- Use conventional filters instead of membranes	9	Wesner
N2-Sequester iron and manganese, eliminate membranes (not viable if source is deemed ground water under the influence of surface water)	0	
N3-Use submerged membranes (requires two stage pumping)	3	
N4-Use Trident system instead of membranes (idea N1 will provide idea of costs compared to membranes)	5	
N5-Use Greensand filters instead of membranes (idea N1 will provide idea of costs compared to membranes)	See N1	
N6-Use biologic iron and manganese removal process(not widely used, may require two stage filtration because both iron and manganese must be removed)	4	
N7-Self cleaning screens and high rate filter (screens not needed for this ground water supply)	4	
N8-Modify Weyerhauser plant to provide potable water or add separate potable water train (past discussions indicate Weyerhauser not receptive, may not have intake capacity needed for their demands plus City demands)	4	
N9-Use Weyerhauser intake to obtain Columbia River Water and treat at Mint Farm site	NTD	
N10-Use alternate route for new pipeline to distribution system to create a pipe loop	NTD	
N11-Use multiple lines rather than one pipeline to distribution system	NTD	
N12-Go to Columbia River directly rather than through Weyerhauser (requires building new intake, high cost, permitting issues, water quality concerns)	1	
N13-Use Design Build Own Operate approach with	1	

performance specifications (complex and lengthy procurement, current market is limiting competition for this approach)		
N14-Relocate plant to avoid piling	8	Sindt
N15-Get water from Chinook Ventures (inadequate capacity to be full time supply for City)	1	
N16-Use aeration/detention instead of chemical oxidation	NTD	
N17-Use Design Build Operate approach with performance specifications (complex and lengthy procurement, current market is limiting competition for this approach)	1	
N18-Use dedicated backwash treatment system	NTD	
N19-Eliminate backwash holding pond/pond discharge to sewer (need facility to equalize flow)	6	
N20-Phase membrane modules until demand increases	8	See membrane cost evaluation
N21-Phase wells until demand increases	8	See N1
N22-Use spread footings instead of piling (probably not viable in light of high groundwater)	1	
N23-Use one clearwell instead of two	6	
N24-Use concrete clearwell	7	Hansen
N25-Put distribution pumps on top of clearwell	See N24	