



April 8, 2015

Terri Fraser, P. Eng.
Technical Manager
Northern Pulp
Pictou Mill
PO Box 549, Station Main
New Glasgow, NS B2H 5E8
CANADA

RE: Draft Approval No: 2011-076657-R03

Dear Ms. Fraser:

This letter summarizes my comments on your Industrial Approval 2011-076657-R03 issued March 9, 2015:

1. Water Usage

Based on my review of NPNS data for 2013, my familiarity with this mill for the past nine years, and nearly forty years experience with bleached kraft mills that utilize ASB technology in North America, I disagree with the proposition that NPNS's effluent volume (m^3 /adt) is unusually high. With an average effluent volume of $85 m^3$ /adt over the past two years, this mill is between the 50th and 60th percentile of bleached kraft mills in the U.S. and Canada.

ASB technology is widely used in the pulp and paper industry because it is proven technology that is relatively simple and reliable. It has been used throughout North America since the implementation of secondary treatment standards. It has a long history, but is neither outdated nor less reliable than higher rate technologies, such as activated sludge treatment (AST).

Having conducted on-site and off-site audits of this system since 2005, I am mindful of the importance of solving the TRS issues that impact your neighbors. I also believe this ASB can continue to reliably produce a non-toxic effluent that is compliant with regulations.

2. Water Reduction

The water reduction guidelines stipulated in the approval may have unintended adverse consequences if fully implemented. The stipulated flow rate of $75,000 m^3$ /day by January 30, 2018 is reasonable and achievable. Flow reduction beyond this may be problematic. Longer retention time does not necessarily improve treatment efficiency. In the case of the NPNS effluent treatment system, odour generation in the first settling basin is more likely as retention time increases. Furthermore, most mills find that flow reduction results in an increase in the temperature of the mill effluent. Many ASB and AST systems have experienced instability above $37^\circ C$, a likely scenario at NPNS during summer months, under the proposed water usage limits for 2018 and 2020.

Mills throughout North America are striving to reduce water usage. Idiopathic incidents of *Daphnia* and trout toxicity are increasing. The relationship between flow reduction and increasing toxicity is a matter of concern to many mills, including NPNS. It is important to balance lower water usage goals with the requirement of producing a non-toxic effluent. A compromise in the proposed water reduction schedule will achieve a water conservation objective with less risk of creating toxicity where it doesn't currently exist.

Because the volume of effluent generated by pulp mills varies considerably from day to day, North American mills do not typically have a daily flow limitation. Rather, they are regulated on the basis of daily mass loading, which is flow-dependent. Changing from a daily maximum to an annual average flow limit allows the mill flexibility to operate appropriately without compromising its environmental responsibilities. I suggest the effluent flow approval be based on an annual average rather than a daily maximum limit.

3. ASB Influent TRS concentration vs. flow reduction

Conditions 8d and 8e of the Approval stipulate the following:

- d) The Approval Holder shall conduct operations with the objective of limiting daily loading of total reduced sulphur compounds in the water entering the effluent treatment system to the following levels:
 - (i) 0.98 kilograms of total reduced sulphur compounds per air dried unbleached metric tonnes of pulp (kg/adubmt) by July 1st, 2016;
 - (ii) 0.658 kilograms of total reduced sulphur compounds per air dried unbleached metric tonnes of pulp (kg/adubmt) by July 1st, 2017; and
 - (iii) 0.335 kilograms of total reduced sulphur compounds per air dried unbleached metric tonnes of pulp (kg/adubmt) by July 1st, 2021.
- e) The Approval Holder shall conduct an assessment of total reduced sulphur levels in wastewater in comparison to the performance objectives established in Condition 8(d) of this Approval. Monitoring of total reduced sulphur in wastewater shall be conducted in accordance with Table 6 of Appendix A of this Approval. The Approval Holder shall submit an annual report of wastewater total reduced sulphur loading results for the previous year to the Department by June 30th each year.

Having an enforceable and scientifically sound method of managing TRS emissions and ensuring compliance with ambient air standards is essential. It is unclear how the incoming sulfide concentration (Point A) can reliably serve as a predictor of air emissions around the ASB. I am not aware of any mill that is managing effluent system odour by limiting the influent TRS as described in the Approval.

The flow reduction requirement conflicts with Condition 7j and 8d. It is not logical to expect the wastewater flow to be reduced without a corresponding increase in the concentrations of TRS, BOD, TSS, and all other constituents comprising the waste stream. I recommend replacing Conditions 6b and 6c with a requirement that TRS concentrations be measured at the fence line of the effluent treatment centre and be managed accordingly.

As a practical matter, nuisance odours are least likely under the following circumstances:

1. Higher hydraulic load (Reduce retention time in the settling pond and the amount of TRS generated by sulfur reducing bacteria.)
2. Lower temperature (Lower anaerobic metabolic rate in the settling pond and lower rate of TRS volatilization.)
3. Diligent sludge management (Prevent the excessive accumulation of sludge in the

settling pond or ASB.)

4. Diligent pH management (Maintain the inlet to Pond A above 7.5 with no upper limit, as long as the inlet of Cell 1 is within a range of 7.0-8.5.)
5. Diligent dissolved oxygen management (maintain a D.O. residual of >0.5 ppm within ASB Cells 1, 2 and 3.)

4. New vs. Existing Effluent Treatment Technology

Due to space limitations, a new effluent treatment system would logically require the design and construction of a more complex system, most likely activated sludge treatment. Unfortunately, the odour challenges at the current location would not be eliminated by selecting a higher rate and more complex technology. In my forty year career troubleshooting pulp mill effluent treatment problems, I have encountered as many TRS issues at mills that utilize AST technology as those with ASBs. AST systems are more intensely aerated than ASBs and consequently more prone to TRS volatilization. The sludge handling systems associated with ASTs are commonly the root cause of TRS complaints. This is less often the case with ASBs. In addition, AST staff competency is more rigorous due to the higher level of technical and mechanical complexity. While the NPNS ASB is classified as a Grade III facility, an AST would be undoubtedly be reclassified as a Grade IV, which significantly increases the on-going operation and maintenance costs.

In light of the capital cost to construct a new effluent treatment system; the potential that odour issues will not be put to rest in doing so; the higher cost and complexity of operation; and the risks associated with a high-rate system, a requirement to abandon the current assets in favour of a new system is untenable. The current system can reliably produce a compliant effluent. In addition, the air quality issues associated with the ASB can be improved without abandoning this system.

COD Limits, BOD vs. COD Testing

The 11,890 kg/day COD limit at Point C is unrealistic. Standard kraft pulping would be expected to generate 80 kg COD/t (NCASI 2013.) At a reference production rate of 873 t/d, this is 69,840 t COD/d. Assuming a 44% COD reduction can be achieved via biological treatment, 69,840 t COD/d measured at Point A would produce an effluent with 39,110 kg/d at Point C (NCASI 2013).

Even with extended cooking and oxygen delignification, 27 kg COD/t (23,571 kg COD/day) would be generated (NCASI 2013). Assuming a 44% COD reduction via biological treatment, 13,200 kg COD/day would be expected at Point C.

I am unaware of any North American softwood kraft mill currently producing treated effluent that would comply with the COD limits stipulated in the Approval.

COD and BOD represent different methods of measuring the oxidizable matter in a water sample. I am curious why COD has been added as a regulatory parameter for this mill. In North America, BOD is the standard by which organic loading is regulated. BOD directly measures the amount of oxygen required by aquatic microorganisms to stabilize (degrade) organic compounds. COD, on the other hand, uses a strong oxidizing chemical to measure the oxidizable compounds in a sample, which naturally includes compounds that are not biodegradable. COD is always higher than BOD for this reason. The COD:BOD ratio changes quite significantly between the influent and effluent samples due to the fact that only a portion of the COD is degradable. The remainder is considered refractory (biologically inert).

Consider the simple walnut. It consists of edible and non-edible parts, the nut meat and the shell. If one were interested in the food value (calories) of a walnut, attention would be focused on the nut meat, which is the part eaten because it can be digested (biodegradable). This is analogous to the BOD portion. The whole walnut, including the shell, is analogous to the COD. If one were to put the entire nut in a furnace, both the meat and the shell would combust. Although though the shell burns it isn't a useful food source. So it is with BOD and COD measurements. These are different tests, conducted on the same sample, for different purposes. BOD is useful because it directly reveals the oxygen demand of a sample in an aquatic environment. COD is useful because it can be performed more quickly than the BOD test. As such, COD is used to measure and manage process streams within the mill, and oftentimes serves as the basis for a mill's best management practices (BMP) plan.

Standard softwood kraft pulping generates 16 kg BOD/t (NCASI 2013a). Assuming 85% removal via biological treatment, treated effluent would be expected to contain 2.4 kg BOD/t. At the reference production rate of 873 t/day, 2,095 kg BOD/d is forecast. A review of 2014 records shows that NPNS produced an annual average of 1,354 kg BOD/d, which is 35% better than average.

A COD reduction of 10% by January 30, 2018 is reasonable, as measured at Point A. A reduction of 50% by January 30, 2020 is unrealistic and incongruous with the effluent BOD limit of 40 mg/L listed in Table 6A.

I suggest that the performance of this effluent system continue to be based on BOD and that COD be used to monitor and control wastewater within the mill prior to discharge to the effluent treatment center (Point A).

Retention Time

The hydraulic retention time (HRT) of 4.9 days stated in the Amec report (2010) did not consider dredging projects that subsequently increased the retention time to the current 5.9 day HRT. This is more than a marginal improvement. The current HRT is working quite well as evidenced by exemplary BOD removal performance. The HRT compares favourably with other North American mills. Additional treatment time would not significantly improve the quality of the treated effluent.

Sincerely,

Callan & Brooks, Inc.



Paul H. Klopping, Principal

References

National Council for Air and Stream Improvement, Inc. (NCASI). 2013a. *Environmental Footprint Comparison Tool- Effects of Decreased Release Of Chlorinated Compounds on Discharge to Water, Wastewater Pollutants Other than Organochlorine Compounds*.

U.S. Department of Energy (USDOE). 2005. *Energy and Environmental Profile of the U.S. Pulp and Paper Industry*. p. 62.

AMEC, April 2010. *Boat Harbour Return to Tidal Re-Evaluation*.

National Council for Air and Stream Improvement, Inc. (NCASI). 2013(b) *NCASI Handbook of Environmental Regulations and Control, Volume 1: Pulp and Paper Manufacturing*.

USEPA, 40 CFR Parts 63, 261 and 430, *National Emission Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production; Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper and Paperboard Category*, Federal Register Vol. 63, No. 72, April 15, 1998

Pulp and Paper Experience

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| Company | Location | WWTP | Contact | Micro Exam | Training | Tech Assist | Design Review | Compliance |
|--------------------------------------|-------------------------|-----------|--------------------|------------|----------|-------------|---------------|------------|
| Alabama River Pulp | Perdue Hill, AL | UNOX | Mark Hendrix | ■ | ■ | ■ | ■ | ■ |
| Alberta Newsprint | Whitecourt, Alberta | A/S | Dan Moore | | ■ | ■ | | |
| Avenor (Abitibi Price) | Chandler, Quebec | A/S | Jean Guérard | | | ■ | ■ | ■ |
| Boise Cascade | St. Helens, OR | ASB | Jeff Sorenson | ■ | ■ | ■ | ■ | ■ |
| | Wallula, WA | ASB | Ray Lam | ■ | ■ | ■ | ■ | ■ |
| Blue Ridge Paper | Canton, NC | AS | Paul Dickens | ■ | | ■ | | |
| Canadian Pacific Forest Prod. | Thunder Bay, Ontario | UNOX | Rick McMullen | | ■ | ■ | ■ | |
| Cariboo Pulp | Quesnel, BC | A/S | Sheila Murland | | ■ | | | |
| Cascade Pacific Pulp, LLC | Halsey, OR | ASB | Lisa Scott | ■ | | ■ | ■ | |
| Catalyst Paper | Powell River, BC | UNOX | Sarah Barkowski | ■ | ■ | ■ | ■ | ■ |
| | Port Alberni, BC | A/S | Larry Cross | ■ | ■ | ■ | ■ | |
| | Elk Falls, BC | UNOX | Brian Houle | ■ | | ■ | ■ | ■ |
| | Coquitlam, BC | A/S | Janet Tecklenborg | ■ | ■ | ■ | ■ | ■ |
| | Crofton, BC | UNOX | Michelle Vessey | ■ | ■ | ■ | ■ | |
| CPL Paperboard Ltd. | New Westminster, BC | ASB | Luc Burelle | | ■ | ■ | ■ | ■ |
| Clearwater Paper | Lewiston, ID | ASB | Bill Hoesman | ■ | ■ | ■ | ■ | ■ |
| | E. Hartford, CT | Primary | Marv Lewallen | | | ■ | ■ | ■ |
| | Wiggins, MS | Primary | Gavin Black | | | ■ | ■ | ■ |
| | Neenah, WI | Adv. Pri. | Tracey Driessen | ■ | | ■ | ■ | ■ |
| | Ladysmith, WI | A/S | Kevin Ovans | ■ | | ■ | ■ | |
| Daishowa America | Port Angeles, WA | A/S | John Boyd | | | ■ | ■ | ■ |
| Daishowa-Marubeni Int. | Peace River, Alberta | A/S | Tom Tarpey | ■ | ■ | ■ | ■ | ■ |
| Domtar | Lebel-sur-Quevillon, QC | A/S | Amy Lo | | ■ | ■ | ■ | |
| | Cornwall, ON | A/S | Murray Grant | | ■ | ■ | ■ | |
| | Port Edwards, WI | UNOX | Rob Goggins | ■ | | ■ | ■ | ■ |
| | Port Huron, MI | A/S | Christine Loeffler | ■ | | ■ | ■ | ■ |
| Eurocan Pulp & Paper | Kitimat, BC | ASB | Michael Martins | ■ | ■ | ■ | ■ | ■ |
| Fibreco (Slocan) Forrest Prod | Taylor, BC | A/S | Mike Wilchewski | | ■ | ■ | ■ | ■ |
| Finlay Forest Industries | Mackenzie, BC | A/S | Lorena Mueller | | ■ | ■ | ■ | ■ |
| Georgia Pacific | Atlanta, GA | ASB | Robert Sackellares | | ■ | | | |
| | Wauna, OR | A/S | Jeff Sorenson | ■ | | ■ | ■ | ■ |
| | Halsey, OR | A/S | George Appleton | | ■ | ■ | ■ | |
| Grand Rapids PUC | Grand Rapids, MN | A/S | Jim Ackerman | | ■ | ■ | ■ | |
| Harmac Pacific | Nanaimo, BC | A/S | David Bramley | | | ■ | ■ | |
| Howe Sound Pulp & Paper | Port Mellon, BC | UNOX | Siew Sim | ■ | ■ | ■ | ■ | ■ |
| Hinton Pulp | Hinton, BC | ASB | Jennifer Fowler | ■ | ■ | ■ | ■ | ■ |
| Inland Empire Paper | Spokane, WA | A/S | Bob Sallee | | | ■ | | ■ |
| International Paper | Kaukauna, WI | A/S | Joel Haarala | ■ | | | | |
| | Pensacola, FL | ASB | Mike Foster | ■ | | ■ | ■ | |
| | Courtland, AL | A/S | Steve Rickman | ■ | | ■ | ■ | |
| Irving Paper | St. John, NB | ASB | Dereck Forsythe | ■ | ■ | ■ | ■ | ■ |
| Kimberly-Clark | Everett, WA | A/S | Robert Waddle | ■ | ■ | ■ | ■ | ■ |
| | Beech Island, SC | ASB | Matt Campanero | ■ | ■ | ■ | ■ | |
| | Owensboro, KY | A/S | Richard McGuffin | | ■ | ■ | ■ | |
| | Loudon, TN | A/S | John McKinnon | | ■ | ■ | ■ | |
| | Corporate, Roswell, GA | A/S-ASB | John McKinnon | ■ | ■ | ■ | ■ | ■ |
| | Jenks, OK | A/S | Cathy Via | ■ | ■ | | | |

Pulp and Paper Experience

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| Company | Location | WWTP | Contact | Micro Exam | Training | Tech Assist | Design Review | Compliance |
|----------------------------------|----------------------|------|-------------------|------------|----------|-------------|---------------|------------|
| Millar Western | Whitecourt, AB | A/S | Pat Parent | | | | | |
| Neenah Paper | Whiting, WI | A/S | John Kohler | | | | | |
| | Neenah, WI | A/S | Steve Hagglund | | | | | |
| New Page | Escanaba, MI | A/S | Bill Racine | | | | | |
| | Luke, MD | A/S | Scott Shoemaker | | | | | |
| | Rumford, ME | A/S | Stephen Fuller | | | | | |
| | Whiting, WI | A/S | Deanna Haen | | | | | |
| | Wisconsin Rapids, WI | A/S | Matt Wojahn | | | | | |
| Northern Pulp Nova Scotia | Pictou, Nova Scotia | ASB | Dave Davis | | | | | |
| PaperWorks Industries | Wabash, IN | AS | Dan Lunsford | | | | | |
| Papiers Scott Limitee | Crabtree, Quebec | A/S | Gilles Jasmin | | | | | |
| Pine Falls Paper | Pine Falls, Manitoba | A/S | Ken Peacock | | | | | |
| Ponderay Newsprint Co | Usk, WA | A/S | Lori Blau | | | | | |
| Pope and Talbot | Mackenzie, BC | ASB | Rick Hogan | | | | | |
| | Harmac, BC | A/S | David Bramley | | | | | |
| Port Townsend Paper | Port Townsend, WA | ASB | Annika Wahlehdahl | | | | | |
| Sachsien Paper | Eilenberg, Germany | A/S | Juha Varpula | | | | | |
| SCA Tissue | Flagstaff, AZ | A/S | Pat Pena | | | | | |
| | Barton, AL | A/S | Randy Paff | | | | | |
| Simpson Tacoma Kraft | Tacoma, WA | UNOX | Randy Sousley | | | | | |
| Slave Lake Pulp Corp | Slave Lake, Alberta | A/S | Rick Denton | | | | | |
| Sonoco Products Co. | Sumner, WA | A/S | Forrest Ballard | | | | | |
| ST Paper, LLC | Oconto Falls, WI | A/S | Stephen Lea | | | | | |
| Stimson Lumber Co | Forest Grove, OR | A/S | Jim Skuzeski | | | | | |
| Temple-Inland | Ontario, CA | A/S | Mike Franklin | | | | | |
| | Rome, GA | A/S | Russ Foulke | | | | | |
| Verso Paper | Bucksport, ME | A/S | Cintya Bailey | | | | | |
| | Jay, ME | A/S | Rick Toothaker | | | | | |
| Wausau Paper | Groveton, NH | A/S | Dennis Bacon | | | | | |
| West Linn Paper | West Linn, OR | ASB | Penny Machinski | | | | | |
| Western Pulp Ltd. | Port Alice, BC | A/S | Ron Palmer | | | | | |
| | Squamish, BC | UNOX | Jeanne Taylor | | | | | |
| Weyerhaeuser Corporation | Longview, WA | A/S | Carla Beckstrom | | | | | |
| | Cosmopolis, WA | A/S | Dennis Davies | | | | | |
| | Albany, OR | ASB | Chuck Mihalko | | | | | |
| | Oxnard, CA | A/S | Steve Perkins | | | | | |
| | Valliant, OK | ASB | Jerry Baber | | | | | |
| | Rothschild, WI | A/S | David Faucett | | | | | |
| Zelstoff Celgar | Castlegar, BC | A/S | Roger Orser | | | | | |



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Principal, Callan and Brooks, Inc.

B.S. Microbiology, California State University, Long Beach (1971)
Post Graduate Study, Microbiology (2 years), California State University
Certified Operator, Grade IV, Wastewater Treatment, State of Oregon #2841
Certified Operator, Grade II, Water Treatment, State of Oregon #1704
Certified Environmental Trainer, NETA #94267

Professional Background

Mr. Klopping is an expert in biological wastewater treatment where he specializes in troubleshooting, process control, solids handling and facility management. He was the chief operator of the Sweet Home, Oregon advanced wastewater treatment plant where he earned a Class IV wastewater treatment license and a Class II water treatment license. As a former Department Chairman and Instructor of the water/wastewater technology program of Linn-Benton Community College, Mr. Klopping is well versed in all aspects of materials, curriculum and training program development and delivery. Mr. Klopping is a charter member and Past President of the National Environmental Training Association. He is also Past-President of the Pacific Northwest Clean Water Association, a member association of the Water Environment Federation.

Following his seven year tenure at Linn-Benton Community College, Mr. Klopping founded Environmental Training Consultants (ETC) and served as president for 16 years. ETC specialized in environmental training, technical assistance and facility O & M. From 1996-2001 he served as a senior vice president at Brown and Caldwell, an environmental engineering design firm with 1,200 employees in forty offices throughout the United States. He had company-wide responsibility for the Industrial Water Quality practice and served as a senior consultant in the company's municipal business consulting practice. He is currently the owner and a principal of Callan and Brooks, Inc. where he provides training and technical assistance to improve the operational efficiency of industrial and municipal wastewater treatment facilities.

Pulp and Paper Wastewater Experience

Alabama River Pulp, Purdue Hill, Alabama (2008-2014). Conducted comprehensive performance evaluations to determine the causes of compromised performance. Evaluated the impact of the biodiesel plant on the mill's UNOX system. Evaluated laboratory procedures and recommended changes to improve accuracy of data. Conducted dissolved oxygen profiles, clarifier mass balance utilizing state point analysis, and assessed nutrient management strategy. Recommended comprehensive correction plan.

Alberta Newsprint, Whitecourt, Alberta, Canada. (1991). Consulted on filamentous bulking following start-up of new secondary treatment facility. Prepared and delivered on-site training program.



Alberta Pacific Forest Products, Athabasca, Alberta, Canada. (2011-2014). Conducted a comprehensive evaluation of the activated sludge system, implemented chemical and biological screening program to improve the stability of the effluent treatment facility.

Avenor, formerly Abitibi Price, La Compagnie Gaspésia Limitée, Chandler, Quebec, Canada. (1995-96). Evaluated and recommended methods to correct design and operational deficiencies in this activated sludge treatment facility.

Avenor, formerly Abitibi Consolidated Paper, LaBaie, Quebec, Canada. (1998), Reviewed operating practices and aeration capacity of this sequencing batch reactor (SBR), provided operational assistance to identify and correct sludge bulking problems.

Boise Cascade, St. Helens, Oregon. (1995-2005). Conducted facility evaluation, on-site training and technical assistance for operators and managers of this pulp and paper aerated stabilization basin. Evaluated ASB foaming problems and conducted review of the mill's BMP plan, recommended operational changes to improve ASB performance. Conducted defoamer trial and developed foam mitigation plan.

Boise Cascade, Wallula, Washington. (1995-2005). Diagnosed and corrected BOD and TSS excursions, conducted facility evaluation, provided on-site training and technical assistance for operators and managers of this pulp and paper aerated stabilization basin. As a member of the process design team, achieved Cluster Rule compliance by upgrading performance of the ASB system. Conducted on-site microbiological characterization of the wastewater treatment system and taught an in-house microbiology workshop.

Blue Ridge Paper, Canton, North Carolina (2008). Conducted microbiological assessment and data evaluation to diagnose and correct filamentous bulking problem. Performed clarifier state point analysis and recommended operating strategy to prevent blanket washout.

Canadian Pacific Forest Products, Thunder Bay, Ontario, Canada. (1992). Developed and delivered on-site training for operators and other mill personnel during commissioning of new pure oxygen activated sludge facility.

Cascade Pacific Pulp, Halsey, Oregon. (2010-2013). Evaluated the capacity of the aerated stabilization basin, utilized the NCASI ASB model to determine the impact of changes in mill loading, performed microscopic characterization of the ASB and final effluent, recommended modifications to increase the capacity of the effluent system and while maintaining compliance with the NPDES permit.

Catalyst Paper, Powell River, British Columbia, Canada. (formerly MacMillan Bloedel, Pacifica Paper, NorskeCanada) (1990-2014). Wrote O&M manual and assisted with commissioning of the Powell River facility. Developed and delivered in-house training for operators and managers of the secondary treatment system. Conducted audit to identify and resolve odor problems related to the primary clarifier and sludge handling system. Performed clarifier stress-testing to determine feasibility of operating the system with two-thirds of the originally designed secondary clarifier tankage. Provided on-site consultation to facilitate recovery of the system following a chemical spill. Reviewed proposed design modifications to relocate the primary clarifier. Developed design rationale for RAS hypochlorination system. Developed on-line effluent training modules for power and recovery personnel. Conducted microbiological characterization of bulking and foaming problems and recommended operational changes to improve operations. Performed



laboratory study to determine feasibility treating wastewater from a proprietary pulping process in the mill's existing treatment facility. Conducted pilot testing to determine the feasibility of co-treating municipal and mill effluent. Provided guidance to correct the root causes of elevated effluent BOD and TSS.

Catalyst Paper, Port Alberni, British Columbia, Canada. (formerly MacMillan Bloedel, NorskeCanada) (1993-2014). Advised Port Alberni millsite on feasibility of meeting proposed provincial regulatory requirements for secondary effluent. Conducted operational audits and delivered in-house training for operators and managers of the secondary treatment system. Performed microbiological characterization of mixed liquor samples during filamentous bulking episodes.

Catalyst Paper, Elk Falls, British Columbia, Canada. (formerly Fletcher Challenge, NorskeCanada) (1995-2010). Conducted operational audits and delivered in-house training for operators and managers of the UNOX secondary treatment system at this kraft mill. Provided on-site consultation to facilitate recovery of the biological system during upsets, recommended corrective actions to resolve compromised performance. Developed design rationale for RAS hypochlorination system. Diagnosed and corrected the cause of BOD exceedances.

Catalyst Paper, Crofton, B.C., Canada. (formerly Fletcher Challenge, NorskeCanada) (1995-2014). On-site troubleshooting to resolve various performance issues, including high clarifier sludge blankets. Designed and delivered training for operators and managers of this UNOX activated sludge system. Conducted operational audits, performed on-site microbiological characterization of the wastewater treatment system, conducted aeration optimization study. Collaborated with mill management to identify and correct high conductivity, high COD, high SVI and foaming problems.

Catalyst Paper Recycling Division, Coquitlam, B.C., Canada. (2007-2010). On-site troubleshooting to improve BOD removal and correct secondary clarifier performance issues, including high sludge blankets. Designed and delivered training for operators and supervisors of this conventional activated sludge system.

Clearwater Paper, formerly Potlatch Corporation, Idaho Pulp and Paperboard Division, Lewiston, Idaho (2002-2014). Provided technical assistance during wastewater treatment plant upsets, conducted facility evaluations, prepared ASB training manual, Participated in NPDES permit negotiations and implemented O&M changes necessary for compliance with new requirements. Conducted primary clarifier evaluation and nutrient optimization study. Performed comprehensive microbiological assessment of the wastewater treatment system. Prepared an odor management plan to comply with regulatory requirements. Evaluated and implemented options to reduce TSS and BOD discharges.

Clearwater Paper, formerly Cellu Tissue, E. Hartford, Connecticut (2011). Evaluated wastewater treatment design and operational practices, recommended improvements to insure compliance with NPDES permit.

Clearwater Paper, formerly Cellu Tissue, Neenah, Wisconsin (2010-2011). Performed microscopic analysis of clarifier biofilm, evaluated the wastewater treatment design and operational practices, reviewed treatment alternatives for phosphorus control.



Clearwater Paper, formerly Coastal Paper, Wiggins, Mississippi (2011). Evaluated the wastewater treatment system, reviewed NPDES compliance history, initiated preliminary engineering study to implement secondary treatment, developed odor mitigation plan.

Clearwater Paper, formerly City Forest, Ladysmith, WI (2011). Evaluated the wastewater treatment system, reviewed NPDES compliance history, performed microscopic assessment and conducted specialized testing to determine the cause of poor settleability. Recommended comprehensive performance improvement plan.

CPL Paperboard Ltd, New Westminster, B.C., Canada. (1994-95). On-site evaluation and correction of performance problems in the aerated stabilization basin. Resolved effluent BOD, TSS and toxicity issues.

Daishowa Marubeni, Inc., Peace River, Alberta, Canada. (2004-2014). Conducted operational audits, performed on-site and off-site microbiological characterizations of the wastewater treatment system and delivered in-house training for environmental technicians, regulatory officials, operators and managers of this Kraft mill. Provided guidance to correct the causes of elevated effluent BOD and TSS.

Daishowa America, Port Angeles, Washington. (1991-92). Consulted in the design and operation of secondary treatment facilities in Port Angeles, Washington. Worked with mill personnel to resolve clarifier upsets. Developed troubleshooting protocol to resolve secondary treatment performance problems during start-up of de-inking (recycled fiber) facility.

Domtar, Lebel-sur-Quévillon, Quebec, Canada. (1995-96). Reviewed the design of a proposed activated sludge treatment facility and suggested changes to improve operability. Produced Operation and Maintenance manuals for this new effluent treatment system.

Domtar, Port Edwards, Wisconsin. (2008). Reviewed the design of the wastewater treatment system and developed an operating strategy to accommodate the permanent closure of the Port Edwards sulfite mill while maintaining treatment of wastewater generated by the Nekoosa kraft mill.

Domtar, Port Huron, Michigan. (2010-2011). Reviewed the design of the wastewater treatment system and performed microscopic analysis of various biofilm samples. Collaborated with environmental department on strategy to control biofilm and improve effluent quality.

E.B. Eddy Forest Products Ltd., Ottawa, Ontario, Canada. (1991). Consulted on the design and operation of a new secondary treatment facility, including review of pilot plant data.

Evanite Corporation, Corvallis, Oregon. (1989-1996). Design review, respirometric modeling of activated sludge plant, process control consultation at this 150,000 GPD extended aeration activated sludge plant treating hardboard wastes in combination with various chemical sidestreams. Reviewed research projects in which anaerobic pre-treatment alternatives were evaluated. Recommended design modifications, nutrient management, aerator placement, O&M program.



Eurocan Pulp and Paper, Kitimat, BC (2005-2010). Conducted annual performance evaluations of the ASB, suggested changes that improved TSS, BOD, terpene, resin and fatty acid removal as part of a comprehensive program to produce a non-tainting effluent. Performed on-site microbiological assessments and conducted in-house training. Developed wastewater compliance strategy necessitated by the permanent shutdown of the mill.

Finlay Forest Industries, Mackenzie, B.C., Canada. (1995). Conducted on-site evaluation of the effluent treatment system, developed and delivered training for operators and managers.

Georgia Pacific (formerly James River Corporation), Wauna, Oregon. (1991-2007). Consulted in the design and operation of secondary treatment facilities at the Wauna millsite. Assisted with diagnosis of sludge bulking problem and associated process control issues.

Grand Rapids PUC (Blandin Paper), Grand Rapids, Minnesota. (1996-2000). Conducted an evaluation of the GRPUC wastewater treatment facility to determine capacity. Provided senior level project review of the 1998 GRPUC Comprehensive Plan. Served as principal in charge of Brown and Caldwell's team which proposed secondary treatment upgrades, including selector technology, biological nutrient control, flow splitting improvements, aeration basin modifications, new secondary clarification, improved RAS pumping system and septage handling.

Harmac Pacific, Harmac, BC, Canada (formerly MacMillan Bloedel, Ltd. and Pope and Talbot) (1990-2013). Consulted in the design and operation of new secondary treatment facilities in Harmac, BC. Advised the mill on the feasibility of meeting proposed provincial regulatory requirements for secondary effluent. Developed and delivered start-up training for operators and managers of secondary system. Managed the production of training manuals for the Harmac facility. Evaluated the feasibility of using the mill's effluent treatment system to co-treat municipal wastewater originating from the Regional District of Nanaimo.

Hinton Pulp, Hinton, Alberta. (2008-2014). Evaluated the capacity of the aerated stabilization basin, assisted mill in calculation of green house gas emissions from the effluent treatment system, conducted on-site assessment to determine the cause of elevated BOD and TSS, developed comprehensive correction plan to maintain permit compliance, advised mill in the allocation of capital intended to improve reliability and performance of the effluent system. Conducted on site microbiological evaluation and trained operating personnel in the use of the microscope.

Howe Sound Limited Partnership, Port Mellon, BC (2005-2014). Developed and presented a working hypothesis to explain toxicity events and recommended actions to correct compromised performance of the UNOX system. Developed and delivered in-house training. Performed microbiological assessments and operational audits to sustain performance improvements. Provided expert opinion to mill's legal counsel during investigation of compliance issues.

International Paper Company, Atlanta, Georgia. (2000). Developed and delivered an activated sludge and aerated stabilization basin workshop in support of IP's annual environmental conference.



International Paper Company, Courtland, Alabama. (2010). Conducted an audit of the wastewater treatment system to determine the impact of the anticipated production of new grades of colored paper. The study focused on the additional hydraulic loading to the system, the effects of color paper production on TOC, BOD and TSS, and the potential effects on the biology, including toxicity, filamentous growth and excessive biological slime.

International Paper Company, Ticonderoga, NY. (2012). Conducted a comprehensive evaluation of the activated sludge system, diagnosed and corrected the cause of poor BOD removal, implemented chemical and biological screening program to improve stability of the wastewater treatment system.

Irving Paper, St. John, New Brunswick, Canada. (1995-96). Conducted facility evaluation, on-site training and technical assistance for operators and managers of this pulp and paper aerated stabilization basin. Represented Irving Paper in meetings with citizen groups and the media.

ITT Rayonier, Hoquiam, Washington. (1977-82). Provided start-up training, process control and troubleshooting at this 30 MGD activated sludge plant. Provided on-site training for operating personnel with responsibility for primary and secondary treatment. Advised mill management on the identification and resolution of activated sludge performance problems.

James River Corporation, Halsey, Oregon. (1993). Consulted in the design and operation of secondary fiber wastewater treatment facility at the Halsey millsite. Assisted with diagnosis of sludge bulking problem and associated process control issues.

Kimberly-Clark (formerly Scott Paper Company) Everett, Washington. (1979-2012). Start-up training, process control, design review, troubleshooting, 20 MGD activated sludge plant treating pulp wastes. Established minimum qualifications for operators of new secondary wastewater treatment system in 1979. Designed pre-qualification exam for selection of operators from the mill's bid list. Designed and instructed in-house training programs which included all aspects of secondary treatment system operation. Served as on-site start-up consultant during first year of operation, resolved technical and personnel issues, established process control program which resulted in full compliance with the NPDES permit. Conducted annual refresher training for operators and managers from 1980 to the present. Provided on-going consultation to identify and resolve technical problems, implement new control techniques to meet changing mill conditions and regulatory requirements. Provided technical guidance in the design and operation of aerobic selectors, and RAS hypochlorination system, conducted selector startup training and provided process control oversight.

Kimberly-Clark Corporation, Beech Island, South Carolina. (2002-2008). Developed and delivered bi-annual 2-day in-house training programs to improve the operation of the aerated stabilization basin (ASB) and recertify operational and management personnel.

Kimberly-Clark, Owensboro, Kentucky and Loudon, Tennessee. (1997-2001). Conducted operational review of wastewater treatment plant design. Upgraded two activated sludge facilities to include state-of-the-art selector technology.

Kimberly-Clark Corporation, Roswell, Georgia. (1998). Developed and delivered a 5-day wastewater treatment course for K-C's annual environmental conference at corporate headquarters. Workshop was attended by 45 employees from K-C mills throughout the world.



Kimberly-Clark, Jenks, Oklahoma. (1999). Developed and delivered an on-site training program for operators and managers of this activated sludge system treating wastewater from a recycle paper mill.

Millar Western Paper Company, Whitecourt, Alberta, Canada. (1992). Consulted in the design and operation of secondary treatment facilities at the Whitecourt millsite. Assisted with diagnosis of sludge bulking problem and associated process control issues.

Neenah Paper, Whiting, Wisconsin. (2004-2006). Conducted comprehensive performance evaluation, including microbiological evaluation of MLSS to determine the cause of poor settling. Implemented RAS chlorination program and revised process control strategy. Developed and delivered in-house training program. Developed comprehensive process control program and data management system. Conducted annual follow-up operational audits.

Neenah Paper, Neenah, Wisconsin. (2006-2007). Conducted operational audit to determine WWTP capacity, developed list of performance-limiting factors, recommended modifications to O&M practices, suggested capital improvements, reviewed proposed aeration system modifications and recommended off-gas testing.

NewPage Corporation (formerly Stora Enso), Whiting, Wisconsin. (2005-2014). Conducted on-site facility evaluation, including microbiological evaluations of MLSS to determine the cause of poor settling. Performed off-site microbiological assessments during filamentous bulking episodes, conducted clarifier state point analyses and recommended control tactics to prevent blanket washout. Developed operational strategy necessitated by reductions in the flow and loading to the wastewater treatment system resulting from a partial mill shutdown.

NewPage Corporation, Rumford, Maine. (2011-2014). Conducted comprehensive on-site facility evaluation, including microbiological evaluations of MLSS to determine the cause of poor settling. Recommended operational strategy to correct causes of poor viability and poor flocculation. Provided on-site training to implement operational improvements.

NewPage Corporation (formerly Stora Enso), Wisconsin Rapids, Wisconsin. (2006-2014). Conducted on-site facility evaluation, performed off-site microbiological assessments during filamentous bulking episodes, reviewed operational data and recommended control tactics to improve sludge settleability.

NewPage Corporation, Escanaba, Michigan. (2008-2013). Performed off-site microbiological assessment to diagnose and correct a nutrient-deficiency related filamentous bulking episode, conducted on site comprehensive evaluation, reviewed operational data and recommended a control program to improve BOD removal and sludge settleability, developed and delivered in-house training program.

NewPage Corporation, Luke, Maryland (Upper Potomac River Commission, Westernport, Maryland). (2007-2008). Performed off-site microbiological assessment to diagnose and correct a clarifier solids separation problem, conducted on-site evaluation of the POTW and significant industrial contributors, recommended a comprehensive correction program as part of a NPDES compliance strategy.



NLK-Celpap Canada Inc., Vancouver, B.C., Canada. (1991). Consulted in the design and operation of new secondary treatment facilities for a proposed paper mill in Vanderhoof, B.C.

Northern Pulp Nova Scotia, Pictou, Nova Scotia. (2005-2014). Conducted performance evaluations of the ASB with a focus on nutrient optimization, energy usage, testing routines, aerator location and optimization, instrumentation placement, impact of ASB on eutrophication, and potential use of constructed wetlands as a tertiary treatment option.

Pine Falls Paper, Pine Falls, Manitoba, Canada. (1995-96). On-site evaluation and correction of operational problems occurring during startup of this activated sludge treatment facility.

Pope and Talbot, Mackenzie, British Columbia, Canada. (2001-2003). Conducted comprehensive performance evaluation of the wastewater treatment system for this bleached kraft mill, with particular emphasis on improving performance of the aerated stabilization basin. Represented the mill in permit compliance negotiations with the B.C. Ministry of Environment. Recommended mitigation measures to resolve furan emissions issues.

Port Townsend Paper, Port Townsend, Washington (2008-2014). Provided technical assistance during wastewater treatment plant upsets, conducted facility evaluations, prepared ASB training manual. Performed comprehensive microbiological assessment of the wastewater treatment system. Provided technical assistance to reduce TSS and BOD discharges. Collaborated in the development of an odor mitigation plan. Evaluated the efficacy of internal sludge recycling. Recommended aeration system maintenance and diffuser replacement to mitigate adverse consequences of condensate treatment.

Sachsen Papier, Eilenberg, Germany. (1995). Performed on-site evaluation and correction of operational deficiencies experienced during startup of the activated sludge system supporting this greenfield recycle mill.

Stone-Consolidated Corporation, Steilacoom, Washington. (1996). Evaluation of the effluent treatment system to assess the impact of the cluster rule. Recommended system modifications and operational practices to improve performance.

SCA Tissue (formerly Wisconsin Tissue), Flagstaff, Arizona. (1995-2014). Conducted comprehensive performance evaluation of the wastewater treatment system for this recycled tissue mill. Modified clarifier inlet baffle and set up process control program that allowed the mill to meet permit requirements and lower operating costs. Reviewed new clarifier design proposed by consulting engineer and suggested modifications to improve operability. Performed microbiological characterization of MLSS during periods of poor performance and recommended operational changes to improve operations.

SCA Tissue, Barton, Alabama. (2004-2014). Conducted microbiological examination of activated sludge system, diagnosed and corrected the causes of elevated effluent TSS, designed and delivered on-site training for operators and managers of this recycle mill's wastewater treatment system. Reviewed proposed design for mill expansion, reviewed results of off-gas testing, recommended optimization plan to increase capacity and reduce operating costs.



Slocan Pulp Mill (formerly Fibreco), Fort St. John, B.C., Canada. (1993-2003). Designed and delivered on-site ASB and activated sludge training, advised mill management in the upgrade of the ASB to an activated sludge system. Conducted annual refresher training and provided troubleshooting and technical assistance during upsets. Performed on-site and off-site audits of O&M data and advised management on optimization strategy.

Slave Lake Pulp Corporation, Slave Lake, Alberta, Canada. (1995-2014). Conducted comprehensive performance evaluation of the activated sludge system serving this BCT-MP mill and provided on-site training for operators and managers.

Sonoco Products Company, Sumner, Washington. (2007-2008). Performed microbiological assessments to diagnose the cause of poor wastewater system performance and effluent toxicity.

ST Paper, Oconto Falls, Wisconsin (2005-2014). Conducted operational audit to determine WWTP capacity, developed list of performance-limiting factors, recommended modifications to O&M practices, suggested capital improvements, conducted periodic microscopic analyses to determine cause of poor performance.

Stimson Lumber Company, Forest Grove, Oregon (1986-2013). Conducted operational audits and comprehensive performance evaluation (CPE) for this hardboard manufacturer. Prepared comprehensive correction plan to improve the operation and reduce the O&M cost of the wastewater treatment system.

Tembec Inc. Temiscaming, Quebec, Canada. (1991-93). On-site training in North Bay, Ontario in support of start-up of new secondary treatment facilities at the Temiscaming millsite. Recommended operational control program and design modifications to improve operability.

Temple-Inland Corporation, Ontario, California. (1987-2010). Developed in-house training program, including self-paced modules, for operators and managers of this container board effluent treatment system. Conducted comprehensive plant evaluation and secondary clarifier optimization study.

Temple-Inland Corporation, Rome, Georgia. (2011). Conducted comprehensive performance evaluation to determine the cause of poor settling and elevated effluent BOD and TSS. Developed and implemented comprehensive correction plan.

Verso Paper, Bucksport, Maine. (2010-2011). Conducted comprehensive performance evaluation to determine the cause of poor settling. Developed and implemented comprehensive correction plan. Performed microbiological characterizations and conducted employee training.

Verso Paper, Jay, Maine. (2011-2014). Conducted comprehensive performance evaluation to determine the capacity of this extended aeration activated sludge system to reliably meet its phosphorus discharge limit. Evaluated the system design and anticipated increases in production to determine upgrade requirements.

West Linn Paper Company (formerly Simpson Paper Company, Evergreen Mill) West Linn, Oregon. (1993-2011). Consulted in the design and operation of the aerated stabilization basin at the West Linn mill. Improved nutrient addition and resolved short-



circuiting problems. Performed operational audits, recommended energy conservation and temperature mitigation measures, conducted microbiological characterization of ASB.

Western Pulp Ltd., Port Alice Mill, Port Alice, British Columbia, Canada. (2002-2003). Produced an in-house manual entitled *Managing Hazards in the Workplace–Wastewater Treatment and Sludge Dewatering*. This document addressed concerns of workers regarding exposure to heavy metals, aerosols, pathogens, chemicals and how best to manage health risks associated with wastewater treatment.

Western Pulp Ltd., Squamish, British Columbia, Canada. (1990-92). Consulted in the design and operation of new secondary treatment facilities in Squamish. Developed modular training materials for the new secondary treatment system.

Weyerhaeuser Corporation, Longview, Washington. (1988-2014). Provided in-plant training at this 60 MGD activated sludge plant, Longview, Washington. Developed and instructed three sessions on basic activated sludge operations for a broad cross-section of mill personnel, including operators, laboratory technicians, engineers, mechanics, electricians and instrumentation technicians. Performed comprehensive audit of O&M practices in compliance with court settlement of Sierra Club lawsuit. Performed sanitary wastewater treatment system audits and prepared optimization plans. Provided technical assistance to resolve various process upsets, including sludge handling, high oxygen demand, biofouling, nutrient requirements and inhibitory chemicals.

Weyerhaeuser Corporation, Cosmopolis, Washington. (1995). Evaluated the activated sludge system at this kraft mill to diagnose and correct fecal coliform compliance issues.

Willamette Industries, Albany, Oregon. (1984). Design and operational review, evaluation of extended aeration biological treatment facility. Performed dissolved oxygen and solids profiles of aerated lagoon, advised mill management on sludge handling and aeration requirements.

Willamette Industries, Oxnard, California. (1998-2001). Provided consultation to resolve sludge bulking problems, conducted on-site training for operators and managers of this industrial activated sludge system.

Zellstoff Celgar, Castlegar, British Columbia. (2008-2014). Conducted a comprehensive performance evaluation to determine the cause of unstable TSS performance, evaluated the microbiological condition of the effluent treatment system, assisted mill personnel in troubleshooting effluent treatment problems, including TSS, BOD and toxicity issues. Developed and implemented a comprehensive correction plan. Designed and delivered on-site training. Performed periodic microbiological assessments and data review.

Other Industrial Wastewater Experience

ARCO Alaska, Prudhoe Bay Operations Center, Prudhoe Bay, Alaska. (1991). Designed and delivered in-house training program for operators and supervisors of this ABF/activated sludge treatment plant. Provided on-site technical assistance at the Prudhoe Bay Operations Center.



Coca-Cola Inc., Dunedin, Florida. (1994-95). Conducted comprehensive plant evaluation and developed plan to correct performance problems at this activated sludge treatment facility.

Eastman Chemical, Kingsport, TN, Longview, TX and Columbia, SC. (2007-2012). Performed on-site facility evaluations of the activated sludge systems at the Kingsport, Longview and Columbia sites, performed microbiological evaluation of samples from activated sludge facilities in Kingsport, TN, Franklin, VA, Longview, TX, Rotterdam, Netherlands, and Columbia, SC as part of an on-site training program for environmental managers from manufacturing sites worldwide.

Exxon Refinery, Benecia, California. (1999). On-site consultation to identify and correct activated sludge bulking and foaming problems.

Glanbia Foods, Gooding, Idaho. (2006) Performed microscopic examination of wastewater treatment samples to determine the cause of compromised performance in this anaerobic digester and activated sludge system. Reviewed operational data and recommended performance-improvement options.

Holcim U.S. Inc., Three Forks, Montana. (2002-2012). Performed on-site audit of the sanitary wastewater treatment system at this cement manufacturing facility. Recommended changes in the design and operational practices to ensure compliance. Developed O&M manual and laboratory manual for the package wastewater treatment plant.

McCain Foods USA, Inc., Burley, Idaho. (2005). Performed microscopic examination of lagoon samples to determine the cause of objectionable odors.

Ocean Spray Cranberries, Middleboro, Massachusetts. (1994). Conducted on-site consultation at this industrial activated sludge treatment facility. Identified and corrected sludge bulking episodes. Provided on-going review of operational records and advised plant engineer and operators on methods to mitigate the effects of highly variable pH, temperature, flows, organic loading, and nutrient balance.

Ocean Spray Cranberries, Sulphur Springs, Texas. (1986-2005). Conducted in-house training, process control, design review and troubleshooting. Identified and corrected operational issues which compromised plant performance. Recommended design modifications required to improve facility performance. Produced a comprehensive O&M manual for the OSC Sulphur Springs treatment works.

Ocean Spray Cranberries, Bordentown, New Jersey. (1986-1995). Provided on-site consultation at this industrial activated sludge treatment facility. Identified and corrected sludge bulking episodes. Advised Ocean Spray and its consulting engineers on the operational aspects of the new wastewater treatment facility currently being designed in Bordentown. Identified the need for and assisted in the start-up of sludge handling equipment. Provided on-going review of operational records and advised plant engineer and operators on methods to mitigate the effects of highly variable pH, temperature, flows, organic loading, and nutrient balance.

Ocean Spray Cranberries, Markham, Washington. (1980-2004). Performed operational review of this aerated lagoon. Recommended operating strategy to stabilize performance and ensure compliance with NPDES permit. Conducted environmental audit of wastewater



treatment facility and laboratory (1988), recommended both procedural and facility modifications to improve performance. Conducted a six-month pilot study (1989) which modeled the aerobic treatability of OSC Markham's wastewater and developed design criteria for facility upgrade. Performed O&M audit and recommended process control modifications (2002-2004) to identify and correct the causes of declining performance. Performed a clarifier state point evaluation and provided documentation to support negotiations with regulatory authorities.

Ocean Spray Cranberries, Plymouth, Massachusetts. (1988-95). Prepared in-house training entitled "*Operational Considerations in the Design of Industrial Wastewater Treatment Facilities-1988.*" Designed and delivered an intensive two-day training program for twenty Ocean Spray engineers. Wrote an in-house training manual covering pre-treatment, primary treatment, secondary treatment (aerobic and anaerobic alternatives), sludge handling, process control, local, state and federal regulations, and facility O&M responsibilities. Provided expert opinion to resolve NPDES compliance issues.

Ocean Spray Cranberries, Vero Beach, Florida. (1987-89). Performed operational review of present aerobic biological treatment facility, land application program and deep well injection. Reviewed pilot project data that compared anaerobic and aerobic treatment alternatives.

Naval Supply Center, Manchester, Washington. (1992). Consulted in the design and operation of oily wastewater treatment system, including review of aerobic pilot plant and physical/chemical treatment alternatives.

Sara Lee Bakery, Tarboro, North Carolina. (1993-2007). Conducted comprehensive performance evaluation (CPE) of this industrial activated sludge system, provided on-site technical assistance and training to resolve performance issues, facilitated the design upgrade of the facility to increase capacity and reliability. Investigated and resolved fecal coliform problems associated with the land application of sludge.

Tesoro Refinery, Anacortes, Washington. (2006). Conducted comprehensive performance evaluation of the wastewater treatment system to determine the cause of compromised performance. Investigation included review of operating data, design documents and microscopic characterization of the system.

Tillamook County Creamery Association, Tillamook, Oregon. (1983-2011). On-site consultation at this industrial activated sludge facility. Diagnosed and corrected O&M problems, advised plant manager on process adjustments required for NPDES permit compliance. Provided expert opinion to the company's legal counsel. Implemented filamentous bulking control program, including design of RAS chlorination system.

Trojan Nuclear Facility, Portland General Electric, Rainier, Oregon. (1991-93). Designed and delivered an in-house training program for operators and supervisors of this sequencing batch reactor activated sludge facility. Assisted in the identification and resolution of sludge bulking problem.

Unocal, San Francisco Refinery, Rodeo, California. (1986). Conducted design and operational review, troubleshooting and consultation on phenol and cyanide toxicity as it affected the performance of a 3 MGD ABF/activated sludge plant treating refinery wastes.



West Coast Energy, Taylor, B.C., Canada. (1994). Conducted on-site evaluation of the wastewater treatment system supporting the McMahon gas plant to assess compliance with provincial regulations.

Municipal Wastewater Experience

City of Lewiston, Idaho (2010-2014). Conducted off-site and on-site microbiological evaluations, provided guidance to correct elevated TSS and effluent toxicity problems.

City of Pullman, Washington (2010-2011). Conducted off-site and on-site microbiological evaluations, provided guidance to correct nitrification problems.

Trinity River Authority, Grand Prairie, Texas. (1988-2014). Designed and delivered in-house training programs for operators and supervisors of this 100 MGD activated sludge treatment plant. Conducted on-site technical assistance and troubleshooting during the training programs. Developed an advanced process control workshop and manual for TRA managers. Conducted on-site microbiological assessment of the activated sludge system and provided hands-on process control training.

City of Anacortes, Washington (2006-2011). Designed and delivered in-house advanced activated sludge process control training, including hands-on microbiological assessment. Conducted periodic off-site microbiological evaluations during filamentous bulking events.

City of Medford Regional Wastewater Reclamation Facility, Medford, Oregon. (2002-2005). Produced training manual, developed in-house activated sludge process control training program. Developed and delivered in-house biological nutrient removal training. Performed operability review as part of engineering study to expand capacity of the facility. Conducted hands-on microbiology training to enable the staff to perform filamentous organism identification.

City of Everett, Washington (2005-2007). Designed and delivered in-house activated sludge process control training, including hands-on microbiological assessment. Provided on-site assistance to resolve NPDES compliance issues.

PNCWA, Mt. Vernon, Washington. (2005). Developed and delivered advanced activated sludge process control training, including hands-on microbiological assessment, for twenty-five participants from wastewater treatment plants in Northwestern Washington.

Town of Buckeye, Arizona (2005). Conducted microbiological assessment to determine the cause of activated sludge bulking and foaming problems.

City of Idaho Falls, Idaho (2005). Designed and delivered in-house activated sludge process control training, including hands-on microbiological assessment.

City of Ridgefield, Washington. (2001-2002). Provided start-up services for the new wastewater treatment facility. Prepared the process control section of the O&M manual and delivered operator training.

City of Bellingham, Washington. (1992). Designed and delivered in-house activated sludge process control training, including hands-on laboratory sessions. Provided technical



assistance to resolve a nitrification/denitrification issue and subsequent interference with effluent disinfection.

City of Lynnwood, Washington. (1992-96). Designed and delivered in-house activated sludge process control training, including hands-on laboratory sessions.

City of Yakima, Washington. (1992) Designed and delivered in-house activated sludge process control training, including hands-on laboratory sessions.

City of Homer, Alaska. (1991). Designed and delivered start-up training for operators and supervisors of this new deep shaft activated sludge treatment plant.

City of Edmonds, Washington. (1991). Designed and delivered an in-house training program for operators and supervisors of this new activated sludge treatment plant.

City of Richland, Washington. (1984-90). Provided start-up training, process control management, pretreatment and emergency response program development for this 11 MGD activated sludge plant. Designed and wrote a modular process control manual for operator training and co-authored Richland's *Simplified Emergency Response Manual*. Wrote qualification specifications for the facility manager and conducted nationwide recruitment, participated in the interviews and selection of facility manager. Provided consultation in the establishment of Richland's pretreatment program, including an internal audit to ensure compliance with EPA requirements. Performed treatability analysis in anticipation of accepting wastewater from Hanford Nuclear Reservation 300 Area into city system.

Town of Middleboro, Massachusetts. (1987-89). Conducted comprehensive audit of O&M practices and identified the causes of NPDES noncompliance. Initiated composite correction program which achieved compliance with the NPDES Permit. Represented the Town in negotiations with industry, consultants and regulatory officials in establishing pre-treatment limits, upgrading of treatment plant equipment and modification of operational practices. Provided expert testimony in EPA hearing to resolve Federal lawsuit.

Eugene Regional Wastewater Treatment Facility, Eugene, Oregon. (1986-1989). Developed and instructed in-house training program on basic and advanced activated sludge process control during plant start-up. Conducted follow-up training on activated sludge microbiology and troubleshooting.

Ocean County Utilities Authority, Bayville, New Jersey. (1989). Designed and delivered an in-house training program for operators and supervisors of three activated sludge treatment plants (30-50 MGD each). Produced site-specific training manual for OCUA.

Black Butte Ranch, Sisters, Oregon. (1989-91). Conducted a comprehensive plant evaluation of this activated sludge treatment facility. Performed on-site respirometric modeling of aeration systems. Characterized the facility's strengths and weaknesses, developed a composite correction program to improve the performance of the plant. Recommended design modifications to mitigate O&M problems (1989). Identified cause of filamentous bulking problem and recommended operational changes to mitigate the problem.

National Park Service, Yellowstone National Park, Wyoming. (1979). Provided start-up training and troubleshooting, 5 package wastewater treatment plants and 2 water filtration plants.



City of Sweet Home, Oregon. (1974-76). Chief Operator, 3 MGD activated sludge tertiary treatment plant, Sweet Home, Oregon, Certified Grade IV. Water plant operator, 3.5 MGD potable water treatment plant (mixed media filtration), Certified Grade II.

Training and Curriculum Development

Environment Canada, Ottawa, Ontario, Canada. (1990-92). Designed and delivered six activated sludge training programs for pulp and paper mills in British Columbia, Alberta and Ontario.

TAPPI (Technical Association of the Pulp and Paper Industry), Annual Environmental Conferences. (1994-2004). Developed and delivered TAPPI's Activated Sludge Operations Short Course (1994-1999) and Biological Treatment Short Course (2000-2004). Earned TAPPI's Finest Faculty award for eleven consecutive years.

Montana Environmental Training Center, Yellow Bay, Montana. (1993-2014). Developed and delivered 14 workshops for the advanced wastewater short school at the University of Montana Biological Station at Yellow Bay. Attendees included engineers, regulatory personnel, senior operators and managers from Idaho and Montana.

Environmental Business Specialists, LLC, New Orleans, Louisiana (2002-2012). Conducted activated sludge and ASB training for operators and managers of pulp and paper wastewater treatment systems at annual EBS workshops. Authored and published a 160 page manual entitled *Aerated Stabilization Basin Operation in Pulp and Paper Mills*.

Idaho Operator Upgrade Training Program. (1984-2010). Supervised the program from 1984-1996. Personally delivered over 100 training sessions to operators and managers of Idaho's water and wastewater treatment systems between 1984-2010.

Environmental Protection Agency, Cincinnati, Ohio. (1977-82). Consultant to the National Training and Operational Technology Center, USEPA. Delivered two "Train-the-Trainer" programs designed to improve the effectiveness of instructors responsible for O&M training of wastewater personnel.

University of Massachusetts, Amherst. (1986). Delivered "Train-the-Trainer" program for new wastewater instructors. Demonstrated techniques of instruction in process control of biological treatment facilities.

New England Regional Wastewater Institute, Portland, Maine. (1977-86). Delivered programs on "Troubleshooting Biological Wastewater Treatment Facilities" to operators, managers, consultants and regulatory personnel.

Battelle Laboratories, Columbus, Ohio. (1978-1980). Developed "Train-the-Trainer" workshops on new teaching methods in the areas of Sludge Treatment and Disposal and Activated Sludge Process Control. Delivered six workshops in Columbus, Ohio, Denver, Colorado and San Francisco, California.

Environmental Protection Agency, Cincinnati, Ohio. (1978-80). Consultant to the National Training and Operational Technology Center, USEPA. Project director and principal writer on a performance-based curriculum development project entitled "Sludge



Treatment and Disposal.” Produced 22 instructional modules, each consisting of a slide/tape program (30-60 minutes), student workbook, instructor guide, pre/post-test. Field-tested the curriculum in Cincinnati, Ohio, Albany, Oregon and Honolulu, Hawaii. Modules include:

- Planning Considerations
- Sludge Conditioning
- Flotation Thickening
- Belt Filtration
- Filter Presses
- Drying Beds
- Anaerobic Digestion
- Composting
- Chemical Conditioning
- Chlorine Stabilization
- Land Application
- Sludge Characteristics
- Gravity Thickening
- Centrifugation
- Vacuum Filtration
- Gravity Concentrators
- Aerobic Digestion
- Sludge Lagoons
- Heat Conditioning
- Lime Stabilization
- Incineration
- Landfill

Linn-Benton Community College, Water/Wastewater Technology, Albany, Oregon. (1976-1982). Instructor and Department Chairman. Managed a department of six full time instructors with responsibility for an Associate of Science degree program in water/wastewater technology and a one-year certificate program in water/wastewater operations. Developed and delivered specialized training for off-campus programs on the following topics:

- Activated Sludge Process Control
- Activated Sludge Microbiology
- Principles of Biological Treatment
- Sludge Treatment and Disposal
- Chlorination
- Introduction to Wastewater Treatment
- Water Quality Instructor Development (Train the Trainer)
- Activated Sludge Microbiology/Protozoology
- Laboratory Sampling and Analysis
- Operational Considerations in the Design of WWTPs
- Cross-Connection Control
- Small Water Systems
- Certification Review
- Water/Wastewater Math
- Troubleshooting O&M Problems in WWTPs
- Supervision and Management
- Pre-treatment and Industrial Monitoring
- Pumps and Pumping

Environmental Protection Agency, On-Site Technical Assistance and Training, 104 (g) (1) Program. (1983-85). Conducted on-site evaluation of small wastewater treatment plants under EPA’s program to improve NPDES compliance. Identified O & M deficiencies, provided technical assistance and training to the following communities:

- Dallas, Oregon
- Nyssa, Oregon
- Stayton, Oregon
- Mt. Angel, Oregon
- Riddle, Oregon
- Sutherlin, Oregon
- Roseburg, Oregon
- Waldport, Oregon
- Woodburn, Oregon



Publications and Presentations

Publisher (1984-86), THE BENCH SHEET. A bimonthly, nationally distributed newsletter serving water quality analysts. Wrote technical articles on water and wastewater laboratory operation, quality control, management, training, new techniques. Edited articles submitted for publication from laboratory analysts, consultants and professors throughout the United States. Chaired the Editorial Advisory Board comprised of laboratory analysts and provided oversight in all phases of publication, including article selection, mailing list management, typesetting, proofreading, printing and distribution. Sold the publication to the Water Pollution Control Federation in 1986, its present publisher.

Principal Author, *Aerated Stabilization Basins for Pulp and Paper Mills*, 2003, ISBN 1-883615-41-0, Callan & Brooks Publishing, Inc., Corvallis, OR.

Principal Author, *Activated Sludge Operations for Pulp & Papermills*, 2005, ISBN 1-883615-20-8, Callan & Brooks Publishing, Inc., Corvallis, OR.

Principal Author, *Activated Sludge Process Control and Troubleshooting*, 1995, ISBN 1-883615-30-5, Callan & Brooks Publishing, Inc., Corvallis, OR.

Contributing Author, *Water Pollution Control in the Pulp and Paper Industry*, 1999, with W. Wesley Eckenfelder, principal author, Brown and Caldwell, Nashville, TN.

Contributing Author, *Procedures and Practices in Activated Sludge Process Control*, 1983, Butterworth Publishers, Woburn, MA, 47-52.

Mr. Klopping has written numerous technical papers and delivered over 500 workshops and presentations at local, state, national and international conferences, including those sponsored by the Canadian Pulp and Paper Association (CPPA), the Technical Association for the Pulp and Paper Industry (TAPPI), the Water Environment Federation (WEF), the Pacific Northwest Pollution Control Association (PNPCA), the National Environmental Training Association (NETA), the Environmental Protection Agency (EPA), and Environment Canada.

Professional Memberships

Pacific Northwest Clean Water Association-*Past President*

National Environmental Training Association-*Past President*

Technical Association for Pulp and Paper Industry (TAPPI)-*Finest Faculty Award, eleven consecutive years (1994-2004).*

Water Environment Federation