The UOSA Story

Photos and editing contributed by George Gunn and Tim Gallagher

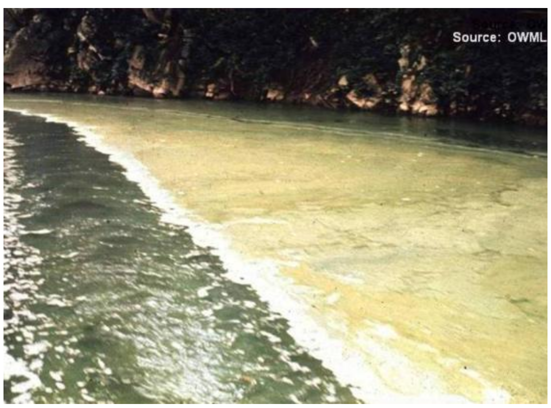
In 2011, CH2M HILL completed 40 continuous years of engineering services for a very important and unique client known by the acronym UOSA. UOSA stands for one of the premier wastewater treatment authorities in the world, the Upper Occoquan Service Authority (formerly the Upper Occoquan Sewage Authority). Born amidst political turmoil, without fiscal support from its founding entities, and tasked with meeting the requirements of then unprecedented stringent effluent discharge standards, the future of UOSA was far from assured at its creation.

Given that at its start on April Fool's Day, 1971, UOSA was, in essence, penniless, why would a fledgling west coast engineering firm have any interest? After all, the recently merged firms that made up CH2M HILL were committed to a market strategy that encompassed the 13 western states, not the 13 original colonies. Two major forces drove CH2M HILL's interest. The first was the unbridled enthusiasm and confidence of a young engineering staff eager to prove they had the ability to make major contributions to the field of environmental engineering. The second was the vision of a young, ex-Navy nuclear engineer named Noman M. Cole, Jr.


Noman M. Cole, Jr.

In the late 1960s, as is the case today, the Occoquan watershed and reservoir was and is a major source of potable water for Northern Virginia's Fairfax County. Adjacent to our nation's capital, the population of Fairfax County began to grow rapidly, beginning in the mid-1960s. Fueled by a seemingly inexhaustible supply of jobs in the capital region and aided by the opening of an interstate highway through the heart of the watershed, the Occoquan watershed became perhaps the most desirable urban development area within the metropolitan Washington because of its easy commuting distance to Washington, D.C.

With growth came water quality problems. Comprehensive water quality studies showed that the Occoquan Reservoir was highly eutrophic and seriously degraded for use as a public water supply. The reservoir experienced frequent and intense blue-green algae blooms, frequent taste and odor problems in the produced drinking water, oxygen loss and subsequent fish kills, increases in organic matter, and actual measured presence of human viruses in the flow stream. This severe and escalating problem was caused by discharge of inadequately treated sewage from 11 secondary treatment plants tributary to the reservoir. At this time in 1970, these small plants contributed approximately 3 million gallons per day of effluent indirectly to the Occoquan Reservoir; and

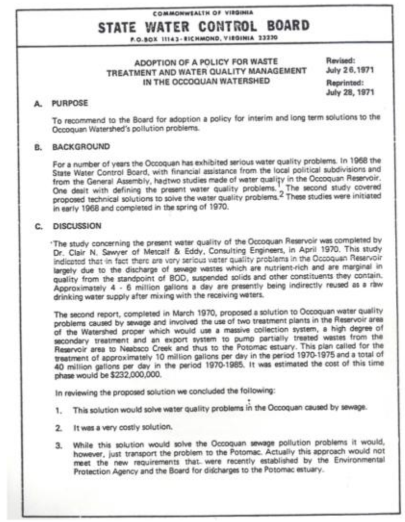


Occoquan Reservoir Algae Bloom: Summer 1973 this amount of effluent was sufficient to cause the serious problems observed. The Virginia State Water Control Board (SWCB) recognized that a detailed study of the situation was required and commissioned a study in partnership with the affected counties of Fairfax, Fauquier, and Prince William Towns of Manassas and Manassas Park as well as the Fairfax Water Authority. An eminent engineer, Dr. Clair H. Sawyer from the well respected Boston consulting firm of Metcalf and Eddy, directed the work. Dr. Sawyer's recommendations, presented in order of their judged capability to minimize reservoir problems, were the following: (1) Exportation of all wastewaters out of the watershed. (2) Application of the highest level of waste treatment technically achievable for direct potable reuse with the treated effluent pumped directly to Fairfax Water Authority's Occoquan water treatment facility for use by the public. In this scenario, only those willing to use the reclaimed water would be allowed to live in the watershed. (3) Limitation of population within the Occoquan watershed to not more than 100,000 plus application of the highest level of waste treatment technically achievable.

These recommendations were refined and subsequently embodied in a comprehensive long-range sewerage development plan developed by Metcalf and Eddy and recommended by them to the Northern Virginia governmental representatives on May 19, 1970. The representatives agreed that a regional approach was needed but objected to the cost, estimated at $429 million. They also questioned Virginia's authority to export wastewater to the Potomac estuary, thus adding to already high nitrogen and phosphorus concentrations therein. Ultimately, Option 3 was selected with the exception of the limitation on population growth. This decision ultimately proved to be visionary because it resulted in protecting and preserving a valuable resource but allowed economic growth to continue in the region and providing high quality water that offsets the deleterious impacts of increasing urban runoff on the Occoquan Reservoir.

The regional approach (Option 3) became more of a reality in August 1970 when the US Environmental Protection Agency (USEPA) advised the SWCB that discharge of secondary-treated effluent within the Occoquan watershed was no longer acceptable and that a high degree of advanced waste treatment (AWT) would be required. Also in August 1970, then Virginia Governor Linwood Holton appointed the outspoken Noman M. Cole, Jr. to the SWCB. The following month, Cole was elected Chairman of the SWCB. By October 1970, Cole had visited and extensively studied the South Tahoe Public Utility District's AWT plant designed by CH2M in consort with Clair H. Hill and Associates. On October 30, he presented a draft report entitled "Tahoe East for the Occoquan" to the watershed jurisdictional leaders. The leaders reacted favorably. This was particularly true of Fauquier County, which was violently opposed to export. Fauquier County contains the upper reaches of the Occoquan Watershed; hence, export lines from it would be long and costly. Projected to generate only 12 percent of sewage flow, its share of capital expense for export would exceed 28 percent, a fact not lost on local politicians. Similarly, Fairfax and Prince William Counties and the then Towns of Manassas and Manassas Park sensed significant cost savings if Cole's recommendation were accepted. Accordingly, in December 1970, Prince William County suggested that those four entities form a sewage authority to be the owner-operator of a Tahoe-type AWT plant in the Occoquan Watershed.

A final version of Tahoe East for the Occoquan report was issued on January 15, 1971; and the SWCB, at its January meeting, adopted a policy for waste treatment and water quality management in the watershed, known as "The Occoquan Policy." The policy required the design of state-of-the-art AWT plants in the Occoquan Watershed be similar to the Lake Tahoe plant. Thus, on April 1, 1971, Fairfax and Prince William Counties and the Towns of Manassas and Manassas Park formed the Upper Occoquan Sewage Authority to own and operate the high-performance AWT plants required by the Occoquan Policy.



COMMONWEALTH OF VIRGINIA
STATE WATER CONTROL BOARD
P.O.BOX 11143 - RICHMOND, VIRGINIA 23230

ADOPTION OF A POLICY FOR WASTE TREATMENT AND WATER QUALITY MANAGEMENT IN THE OCCOQUAN WATERSHED

Revised: July 26,1971
Reprinted: July 28, 1971

A. PURPOSE

To recommend to the Board for adoption a policy for interim and long term solutions to the Occoquan Watershed's pollution problems.

B. BACKGROUND

For a number of years the Occoquan has exhibited serious water quality problems. In 1968 the State Water Control Board, with financial assistance from the local political subdivisions and from the General Assembly, hadtwo studies made of water quality in the Occoquan Reservoir. One dealt with defining the present water quality problems.[1] The second study covered proposed technical solutions to solve the water quality problems.[2] These studies were initiated in early 1968 and completed in the spring of 1970.

C. DISCUSSION

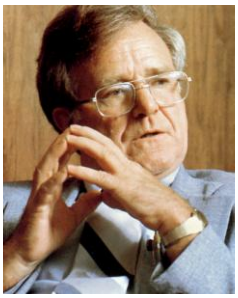
The study concerning the present water quality of the Occoquan Reservoir was completed by Dr. Clair N. Sawyer of Metcalf & Eddy, Consulting Engineers, in April 1970. This study indicated that in fact there are very serious water quality problems in the Occoquan Reservoir largely due to the discharge of sewage wastes which are nutrient-rich and are marginal in quality from the standpoint of BOD, suspended solids and other constituents they contain. Approximately 4 - 6 million gallons a day are presently being indirectly reused as a raw drinking water supply after mixing with the receiving waters.

The second report, completed in March 1970, proposed a solution to Occoquan water quality problems caused by sewage and involved the use of two treatment plants in the Reservoir area of the Watershed proper which would use a massive collection system, a high degree of secondary treatment and an export system to pump partially treated wastes from the Reservoir area to Neabsco Creek and thus to the Potomac estuary. This plan called for the treatment of approximately 10 million gallons per day in the period 1970-1975 and a total of 40 million gallons per day in the period 1970-1985. It was estimated the cost of this time phase would be $232,000,000.

In reviewing the proposed solution we concluded the following:

1. This solution would solve water quality problems in the Occoquan caused by sewage.
2. It was a very costly solution.
3. While this solution would solve the Occoquan sewage pollution problems it would, however, just transport the problem to the Potomac. Actually this approach would not meet the new requirements that were recently established by the Environmental Protection Agency and the Board for discharges to the Potomac estuary.

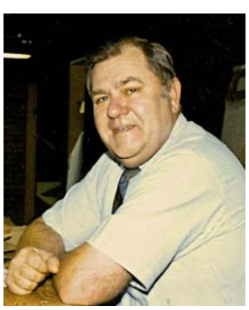
Although the four jurisdictions agreed upon formation of an authority, they and their eight original directors, two from each jurisdiction, agreed upon little else. The four jurisdictions were very dissimilar. Fairfax County was urban and prosperous; Prince William County was largely rural. The two cities were small by comparison. Because the jurisdictions were so dissimilar, agreement on how to jointly share in the costs and apportionment of capacity in a treatment facility was difficult to develop. Issues were compounded by the need in some cases to rebuild existing sewers because of poor construction and massive infiltration problems in many of the cities' sewers. Those that had relatively "tight" sewers wanted to see costs apportioned on the basis of flow; those with leaky sewers preferred costs based on population connected. As Harlan Moyer later observed in a typically understated fashion, "I believe it is fair to say there was not complete unanimity among the political subdivisions about some or all aspects of the situation." Fortunately for the firm, however, the UOSA Directors did agree to issue a request for proposals (RFP) from leading engineering firms to undertake the work needed to provide a Preliminary Engineering Report (PER) that would serve to conceptualize the overall project in conformance with the Occoquan Policy.



Harlan Moyer

Twenty-four engineering firms were invited to submit proposals that included a broad cross section of what at the time were considered leading environmental engineering firms. CH2M HILL was included not because the UOSA Board thought it was a leading firm but because of the firm's work at South Lake Tahoe, which had formed the basis for Cole's Tahoe East report.

Sid Lasswell



Gene Suhr

At this time, CH2M HILL was a regional firm with nine offices principally located in California, Oregon, Washington, and Idaho. It's adopted marketing strategy was to seek and perform work in the 13 western states. Notwithstanding this marketing protocol, Sid Lasswell and Harlan Moyer were determined to respond to the RFP. Together with Gene Suhr, they wrote the proposal and delivered it to UOSA in May 1971. In July 1971, the firm was notified that it was short listed and invited to interview with the authority. Sid, Harlan, and Gene presented our concepts for the project at the interview, which was conducted in borrowed quarters, as UOSA had no offices (or staff for that matter) to call its own at the time. The interview was conducted on a very hot July day, and the eight UOSA Directors were arranged in a semicircle on a platform raised above the interview team. Although the situation was intimidating, the interview went well but was not conclusive. At the end of 2 days of interviews, UOSA was unable to agree upon a clear winner; they were split 50/50, with CH2M HILL still in the running. The deadlock remained until early August when Harlan visited with the authority and committed to the establishment of a permanent Virginia office and the relocation of himself and Gene to be based in the Virginia office for at least the duration of the PER work. Given these promises, the board agreed upon the selection of CH2M HILL.

An excerpt from Harlan's diary for August 1971 memorializes the selection of CH2M HILL as follows: "August 8, 1971 is a date that will live forever in my memory…I arrived in Manassas to sign a contract to provide engineering services for the UOSA Project…At that time, UOSA had a name, a Board of Directors, and a direction to implement the Occoquan Policy…UOSA did not have any staff, any offices, any physical works, and as I subsequently learned, no money!"


Jim Howland

UOSA's lack of funds was a huge problem for the firm at the time because the recent merger of Clair A. Hill and Associates and CH2M (along with recent expansion into Colorado under the 13 western states concept) was somewhat capital intensive. That summer, the CH2M HILL Board had approved an $800,000 five-year term loan and a line of credit that was tied to receivables. Under its terms, the credit line had to be completely paid off for a 30-day period each year. Understandably, a penniless client, however enticing the project was not calculated to enhance the financial stability for the firm. Notwithstanding this, the CH2M HILL Board lined up squarely in favor of the project; and so began a client/project association that continues to the present.

Excerpts from Chairman Jim Howland's report to the firm's directors in September succinctly portray the board's feelings about the UOSA Project. Jim wrote; "Today it (the UOSA Project) appears to offer the greatest single opportunity that we have for becoming a truly major factor in professional services on a national basis…It is hard to imagine a more opportune situation than that which faces us on the east coast…We were selected over 24 of the nation's leading engineering organizations to design the first major AWT plant on the east coast in the shadow of Washington D.C…The project represents a major gamble…In the past much of our work has been on relatively small projects…While we intend to continue this work, it is not possible to adequately compensate or motivate engineers of outstanding capability and reputation with such work…As our people have developed their capability, we are faced with the alternative of either holding them back, having them leave, or providing them a full opportunity for the exercise of their capabilities within our organization…I know of nothing more thrilling, nothing more stimulating than what has happened to us…Our job now is to prove that we are big enough, dedicated enough, and smart enough to make a success of the challenge and opportunity which has been presented to us!"

In September, 1971, Harlan and Gene opened the Virginia office in Reston and began work in earnest on the PER. The project was the firm's first example of its then newly adopted matrix organization on a major project. Under the matrix concept, specialists were assigned to the project from all necessary disciplines from whichever regional office could best supply the needed talent. Project assignments were for both long and short terms as dictated by project needs. Throughout the project, a core team remained involved from start to finish.

An anecdote, again from Harlan's diary, serves to illustrate the early engineering work: "Gene joined me in a few days after I signed the contract, and we began the preparation of the PER…Over the next six months we added some engineering and administrative support staff and worked essentially seven days a week to complete the work…During this time, Gene and I roomed together and became known throughout the firm as the odd couple…Of course, Gene was Felix!"

Gene recalls an interesting situation that happened to the odd couple during the early phases of the PER work. He relates, "It was a very hot and humid summer day in Virginia. I had spent most of that Saturday morning collecting sewage samples from eleven treatment plants. My plan was to freeze the samples and then to fly back to Corvallis for testing. Following my plan, I purchased two five-gallon jerry cans and dutifully began dipping up samples as I drove from plant to plant. Our new office manager's (Gordon Culp) household goods had just been recently delivered and I was pretty sure I could store the samples overnight in their freezer, which I knew stood empty in their garage. Unfortunately, I reckoned wrongly! For some strange reason, housewives don't take kindly to having sewage samples stored in their freezers!

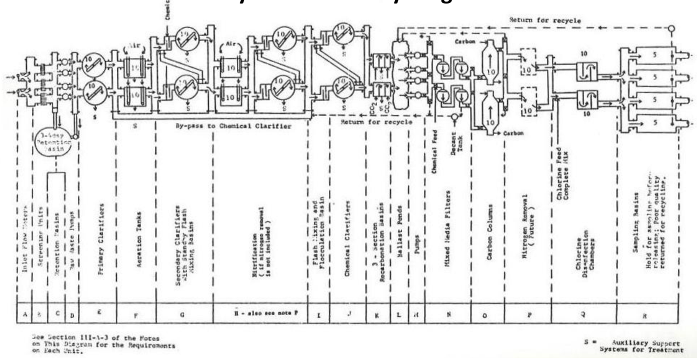
"So there I was, on a hot summer's day with ten gallons of highly perishable sewage on my hands. At the time, Harlan and I were sharing a room at the Dulles Marriott Hotel. The best idea I could come up with was to put the jerry cans in the motel bathtub and pack them in ice from the hotel ice machines. Since it takes a lot of ice to do this, I began roaming the corridors of the hotel with a wastepaper basket as an ice bucket. I probably had emptied about four or five ice machines and thereby depleted at least three wings of the hotel before I had filled the tub with ice. As I was bringing in the last basket full I happened to hear two of the hotel chambermaids in conversation. 'Hey May-belle, there's gonna be one helluva party in 217 tonight!' As it turned out, the maids weren't the only people surprised by my impromptu sample cooler. Imagine Harlan's surprise when he returned to our room with the intention of taking a nice cool shower only to step into a tub full of ice!"

PLANT EFFLUENT LIMITS

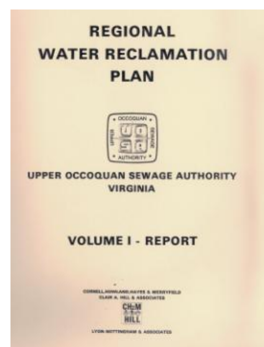
Parameter	Units	Concentration
COD	mg/l	10
Suspended Solids	mg/l	1.0
Unoxidized Nitrogen	mg/l	1.0
Total Phosphorous	mg/l	0.1
MBAS	mg/l	0.1
Turbidity	NTU	0.5
Coliform Bacteria	per 100 ml	<2

As the work progressed, the team became more and more impressed with the Occoquan Policy. This document contained ideas that were unique in the context of conventional wisdom in the design of wastewater reclamation plants and sewerage systems. In 1971, engineers who were responsible for the siting and design of wastewater treatment facilities had little or no inkling of the significant impending changes that were soon to occur in their profession. Nor, other than for a very few, had they ever heard the name of Noman Cole, who was to play such a significant role in causing these changes. Cole, an alumnus of Admiral Hyman Rickover's nuclear submarine program, was a man with a mission. He felt, and rightly so, that the wastewater treatment plants typically being designed and constructed at the time were woefully unreliable and too often allowed bypassing of raw or partially treated sewage as a result of mechanical breakdowns. He felt this reliance on bypassing was unacceptable and that treatment plants could and should be designed to continue to provide complete treatment even in the face of mechanical or other malfunctions. As a result, in formulating the Virginia Water Control Board's Occoquan Policy, he called for an entirely new design concept to be rigorously followed by the designers of the UOSA Project.

Occoquan Policy Original Process Schematic
System Reliability Diagram



An interesting sidelight to the fascinating story of the UOSA project lies within the overall timing of engineering work. In spite of the very rigid design requirements, the Virginia Water Control Board required that the original PER outlining the project design be completed in about 6 months. At the same time, the schedule allowed more than 3 months for the Water Board's engineers to review the report. Compounding the technical difficulties associated with process design was the nature of the service area involved. Bull Run is a tributary stream to the Occoquan reservoir. Along with Manassas, it is steeped in Civil War history. Hence, there was great difficulty in finding sewer rights-of-way and facility construction sites that were not historical sites. Locating suitable sites fell largely to Bill Watters from the Corvallis office, who literally astounded the locals with his knowledge of the history and current and past ownership of the proposed sites. It is a fitting tribute to the CH2M HILL team of environmental engineers who conceived this design that the schedule was met and the completed PER was submitted in February 1972. The PER was well received by the SWCB and the State Health Department called it "Best PER ever reviewed."



The UOSA Board adopted the program recommended in the PER, and all that remained was to begin design and construction. But there still was no money and no UOSA staff. The UOSA Board retained Harlan to work with them and Turner Smith, their attorney, to prepare a service contract between UOSA and the four political subdivisions involved. Only after the subdivisions had signed a service contract could UOSA sell bonds with which to finance the project. This work was greatly aided by Millard Robbins Jr., an engineer from Cole's staff at the SWCB. Finally, after several months, Fairfax County and the two cities had signed a service contract; but Prince William County was still recalcitrant. Harlan's diary puts it this way: "On a dark and stormy night, Turner, Millard and I attended a Prince William County Supervisors meeting and at the eleventh hour the supervisors finally approved the service contract. It had been raining buckets all day and as we came out of the meeting in the early morning hours, it was still raining buckets. Millard looked up to the sky and said ‘OK Noman, you can shut it off now!’ and, Hurricane Agnes ended."

With the service contract completed, the chances for implementation of the project were greatly enhanced; and work could begin on creating a working authority staff and on design of the plant and interceptor sewer system. There would remain many significant obstacles, but truly the worst of myriad problems had been overcome. In July 1972, the authority sold its first bonds, paid CH2M HILL for the PER, and authorized final design of the first 15-mgd increment of treatment capacity.

As preliminary design work began in earnest, the engineering team needed to understand and cope with treatment requirements and design standards that were a total departure from the “usual” engineering practice extant at that time. In comparison with widely accepted design standards such as the Ten States Standards and essentially all other design criteria in common use at the time, the standards demanded by the Occoquan Policy were much more rigorous. Reliability requirements were greatly enhanced, methods for determining plant capacity were drastically altered, power source requirements were made more stringent, overflow containment was required and a whole new vocabulary was needed to address these and the numerous other changes from the status quo of sewerage facilities design as it was then practiced. The entire thrust of these new standards was to ensure that facilities that would be commissioned for use in the Occoquan Watershed would be as reliable as reasonably possible.

Many of the unusually rigorous design requirements required by the Occoquan Policy have found their way into what is today termed "the standard of excellence by which design of sewerage facilities is judged." In this respect, the profession owes a profound debt of gratitude to Cole, without whom it is likely current designs would be considerably less reliable than they are today.


Original UOSA Site, 1971

Having come from a nuclear submarine background, Cole prized the concept of redundancy or back-up systems highly. In his view, the old adage, "if something can go wrong it will go wrong" described a certainty! Therefore a system could not be considered reliable unless redundant systems were available to continue operation in the face of nearly any conceivable malfunction. Nor was a single backup system deemed acceptable. Instead, redundancy in depth was required. Under this concept, two or more means to alleviate a failure were needed. These means might include but need not necessarily be identical standby units.

For example, a treatment plant might require four primary clarifiers in order to provide treatment for a given flow. One form of redundancy, termed in-kind, would be to provide a fifth clarifier that could be pressed into use in the event of failure of one of the operating units. Another form of redundancy might be to design the clarifiers such that only three operating units could accept the peak flow condition, albeit at a somewhat reduced efficiency. If downstream unit processes were designed to be able to accept such reduced efficiency while still providing requisite treatment, a different, yet just as effective form of redundancy would be achieved. If both in-kind and this later form of redundancy were provided, the result would be redundancy in depth.

Wastewater facilities are typically designed to accept a certain amount of peak loading conditions in excess of their average design loadings. Common practice in the 1970s as well as today is to express design capacity as the facilities capability assuming that the largest single machine in a given unit process is out of service. Thus if a sewage pump station had a complement of one 20-mgd pump and four 15-mgd pumps, its peak capacity would be 4 x 15 or 60 mgd, since the largest pump (20 mgd) will at some point in time be out of service.

However if the sewers tributary to the pump station deliver peak flows in excess of average flows for any significant time period, then the firm average capacity or so called design capacity is less than 60 mgd, and the facility would be rated at less than 60 mgd under the Occoquan policy. This illustrates another of Cole's precepts, namely, "if something goes wrong, it will go wrong at the most inopportune time possible." Similarly, under the policy, treatment plant capacities are rated significantly lower than they would be under less stringent design criteria.

At the time, the conventional wisdom was to provide crucial sewerage facilities with dual power supplies. For the most part, this is still the modus operandi of facilities designers. Under the Occoquan Policy this is unacceptable. Dual independent power supplies were required. Power supplies are deemed independent only if a failure anywhere in one system has no impact on the remaining system's ability to deliver uninterrupted power. Thus the insertion of the word independent in the requirement for dual electrical power supplies requires a completely different design that is (even today) nonconventional. Nor were dual independent power supplies deemed sufficiently reliable under the policy. Standby generation sufficient to power critical equipment is required. Sizing of standby generation capacity under the policy's guidelines requires a rigorous analysis of the impacts on overall reliability that might be caused by insufficient capacity to power all electrical systems.

Discussion of such analyses leads directly to introduction of another term unknown to treatment facility designers at the time. That term is failure mode and effects analysis. Such analyses were common in the naval command responsible for nuclear submarine design but were unheard of in the practice of sewage treatment facility design. Simply stated, the requisite analysis was required to systematically describe each and every possible malfunction and to prescribe what actions were to be taken to ensure uninterrupted facility operation.

This became an immensely powerful tool for conscientious designers for two major reasons: First, it forced designers to analyze their creations to determine where potential problems lay and to provide means to ameliorate problems caused by malfunctions. Second, it provided a means to combat malfunctions by investigating multiple avenues of action and designing ready access to those that best contain the problem. A very important side benefit of the failure mode and effects analysis is that it promotes simplicity.

One pet peeve of Cole's was valves. His submarine experience taught him that valves are notoriously unreliable. He therefore espoused what he termed no-valve design. Often it is convenient to use valves to allow machines to accomplish multiple functions. For example, suppose liquid is to be pumped from either of two containers but not both simultaneously. In this case a single three-way valve or two individual valves might be employed to select inflow to a single pump while isolating the remaining container. In either case, a valve failure renders the pump useless for pumping from either container. If the process is critical, a more reliable solution may be to provide two pumps, each connected to its respective container without intervening valves.

The foregoing is a fairly simplistic description of the no valve concept. When one looks carefully at the bewildering maze of piping and valve systems contained in a modern treatment plant, it is not unusual to find numerous valves that serve no useful purpose. A failure mode and effects analysis will assist in ferreting out unneeded valves because it forces the designer to determine whether valves are open or closed for all possible flow routings. Often one will find that one or more of the valves do not require changing regardless of the flow regime analyzed. In other cases, the analysis may indicate that a valve failure is such a significant problem that a large portion of capacity is lost because of the failure. In such a case the remedy may well be to eliminate the valve from the design.

Another element of design dictated by the policy deals with wastewater storage. For example, the policy required that pumping stations be connected to large diked storage lagoons constructed in such a way that sewage that cannot be pumped for whatever reason will overflow into a storage lagoon where it will be contained until the malfunction can be rectified. Similarly, storage of wastewater between unit processes in a treatment plant may serve as redundant capacity.

An example might be having a plant design where biological portions of a plant are designed to provide firm capacity for peak diurnal flows, but downstream processes are designed for only slightly above average flows with the difference between peak diurnal and average flows being contained in a storage pond. Using such storage affords an opportunity to optimize sizing of unit processes, the design of which is controlled primarily by hydraulic parameters. The result may be that such hydraulically sensitive processes may be designed (with appropriate redundancy) to accommodate maximum daily flow rather than the much larger maximum hourly (or shorter duration) flow. This translates into cost savings without jeopardizing operating reliability. The concept of buffering instantaneous demand by means of storage had been used for years in the industrial sector, but oddly, other than at tertiary treatment facilities such as a Lake Tahoe, was not widely used in conventional treatment plant design. This concept has become more prevalent in recent years as discharge standards for numerous treatment plants have become more stringent and plants have discovered the value of this concept in reliably meeting these more stringent limits with newer technologies.

In addition to the design requirements espoused in the Occoquan Policy, pollutant removal requirements for the project were also extremely stringent. Removal of conventional pollutants such as biochemical oxygen demand (BOD) and suspended solids was required down to very low levels. Other, less conventional, measures of pollution were also addressed. These included such measures as total and unoxidized nitrogen, phosphorus, chemical oxygen demand, and others. The degree to which pollutant removal was mandated, in some cases, was so great that standard analytical tests to determine removal were barely able to determine whether or not compliance had been achieved. Along with the requirement for very high degrees of pollutant removal, the Occoquan Policy required that the design of the tertiary treatment facility be completely self-sufficient. This again was a departure from existing practice, particularly as regards to treatment and disposition of solids generated by the treatment processes. Prior to the promulgation of the Occoquan Policy, it was common to find treatment plant designs that handled the issue of solids disposal by means of the rather cavalier notation: “to solids disposal.”

Given the overall project requirements, it was hardly surprising that the overall design of the treatment facility was complex. Many of the processes employed had been previously proven at the pioneering Lake Tahoe tertiary AWT facility. Others, such as the ammonia nitrogen removal process used briefly at UOSA, were truly state of the art. This process, termed ARRP, removed ammoniacal nitrogen through an ion exchange process very similar to zeolite water softeners. The ARRP process, invented by CH2Mers Larry Kepple and Ray Prettyman, did not stop with ammonia removal from the wastewater. It also incorporated a means to regenerate the ion exchange media called Clinoptilolite, and having done so, an innovative method of recovering the ammonia nitrogen from the regenerant solution and converting it into ammonium sulfate, a salable commercial fertilizer. The regenerant recovery method, which employed closed-cycle stripping, represented a logical improvement of the pioneering stripping system first employed at the Tahoe facility.


Composting Facility

Composting digested sewage solids, as a means of converting them into a usable by-product, was another example of the innovative UOSA facility design. The system employed minimized the need for the complex mechanical equipment others were touting at the time. Instead, filter press dewatered solids were mounded into long, dike-like rows that were mixed with woodchips and periodically aerated by a traveling mixer that resembled an oversize roto-tiller. The system, termed "windrow pile composting," proved to be an effective, extremely reliable means of converting the digested sewage sludge into an environmentally safe and useful by-product. This innovation continued until 1997 when the original composting facility was replaced by a rotary dryer system (pelletizer) to process biosolids into a Class A - Exceptional Quality product for reuse as a soil amendment and fertilizer. This change allowed for the continued reuse of the product in an environmentally safe and beneficial way while reducing the process footprint for increased plant capacity. UOSA’s dryer was the first municipal dryer designed in the state of Virginia and the second one designed by CH2M HILL. For redundancy purposes, UOSA also currently has the ability as part of Project 54 plant upgrade and expansion to lime stabilize its digested/dewatered organic solids as well as drying to produce a class A product for reuse.

Although the overall configuration of treatment processes employed at UOSA has changed somewhat over the past four decades, the overall concept has remained remarkably consistent with the system described in the original PER. This concept, a refinement of the Tahoe project, employed biological processes for the bulk removal of conventional pollutants and physical-chemical processes for the remaining treatment. Thus, cost savings afforded by biological treatment helped to minimize overall costs; and the more expensive physical-chemical processes were only used as necessary to augment overall treatment.

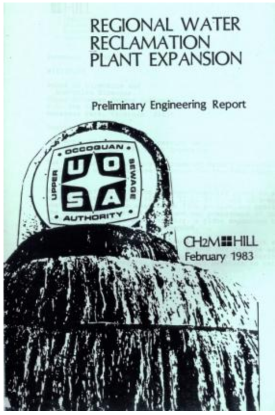
Proj 15 Groundbreaking – L to R George Gunn, Harlan, Mayor Chuck Gogan, ?, UOSA Bd Member Warner Quaisbarth

UOSA's project construction history started in 1973 with what is now called Project 15. Project 15 consisted of the initial 15-mgd (maximum 30-day flow) regional water reclamation plant; five major pumping stations; and 150,000 feet of interceptor sewers and force mains. These facilities were designed to eliminate the 11 existing inadequately performing secondary wastewater treatment plants and thus bring the wastewater flows being generated by UOSA's four member jurisdictions to a new state-of-the-art AWT water reclamation plant for an unprecedented high level of treatment and ultimate discharge to the Occoquan Reservoir.

Due to the lack of available federal and state construction grant funding to construct the entire project out of any one fiscal year's allocation, the water reclamation plant portion of UOSA's Project 15 had to be broken down into multiple construction bid phases over the FY 1973-1975 time period. To complicate plant construction matters even more, EPA imposed what was called "the operable unit concept," which required that treatment plant facilities being constructed in multiple phases due to grant funding limitations, at least conceptually, had to appear to be able to provide for a higher level of treatment than currently being provided by the plant facilities being phased out. This requirement created the need for UOSA to construct its five pump stations, 150,000 feet of interceptor sewers and force mains, and the AWT portion of the water reclamation plant first.

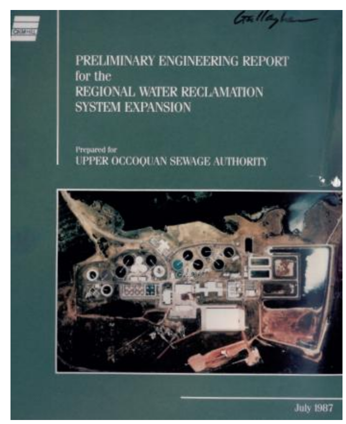
Proj 15 Startup -1978, L to R - ?, T. Scharberg, Reg DEQ Dir., E. Woznicak, D. Rippon, M. Robbins, ?, G. Gunn

The total construction cost for Project 15 was approximately $78 million and took 5 years (between the fall of 1973 and summer of 1978) to construct. CH2M HILL provided all the requisite engineering services required to facilitate timely completion of the project, including preliminary engineering studies, pilot studies, financial analysis, design, construction contract administration and inspection, staff training, startup, and long-term operations assistance. Since going into operation in July 1978 treating 4 mgd, UOSA's water reclamation plant has consistently met the most stringent wastewater treatment requirements of any plant permitted in the United States and is considered a worldwide indirect water reuse benchmark project.



By 1983, due to the rapid rate of population growth occurring in Northern Virginia as a whole, UOSA needed to begin planning for the treatment capacity expansion of its water reclamation plant. A new PER recommended that expansion of the existing Project 15 plant to its full potential capacity of 27 mgd (maximum 30-day flow) was required to meet the population growth projections provided by UOSA's four member jurisdictions. Project 27 was designed in 1984 and constructed in the 1985-1987 time period. Annual inflow rate increases coming to the plant were occurring at such a rapid rate during this period that the then-existing Project 15 secondary treatment portion of the UOSA plant began to show signs of complete nitrification failure due to being overloaded. However, the contractor was able to get the added aeration basin tanks and secondary clarifiers constructed and operational before significant deterioration of the ability of the plant to achieve complete nitrification was lost. This experience clearly demonstrated that future expansions needed to be planned for and implemented in a more timely fashion to protect the public. This realization also resulted in a change in the Occoquan Policy that had previously limited the size of incremental expansions. The total construction cost of Project 27 was approximately $21 million and took 3 years to construct. CH2M HILL again provided all the requisite engineering services to facilitate the timely completion of this plant expansion project.

In 1985, UOSA again solicited revised 20-year (1995–2015) population growth and flow projections from its four member jurisdictions. Based upon the projections received, it became apparent that UOSA needed to again begin the process immediately of planning, designing, and constructing those facilities necessary to both convey and treat the projected increased wastewater flows. In August 1986, CH2M HILL was selected by UOSA to prepare a new PER outlining those treatment and conveyance projects necessary to meet these needs. With approval of the PER, CH2M HILL was authorized in July 1988 to proceed with the design and ultimate construction of the recommended treatment facilities of what became known as Project 54.



The PER initially recommended that the plant capacity be expanded to 45 mgd (maximum 30-day flow). However, given the level of uncertainty associated with the jurisdiction's ability to project their future treatment capacity needs and the construction cost economy to be achieved by constructing the additional 9 mgd capacity sooner rather than later, Fairfax County opted to pay for the added 9 mgd of capacity and thus proceed with expanding the water reclamation plant to 54 mgd.

Given the time it would take to design and construct Project 54, it was also recommended that UOSA consider the construction of several interim projects. These projects would provide the necessary additional short-term treatment plant capacity and delivery system infrastructure required to bridge the time period it would take to fully implement doubling the size of UOSA's existing treatment plant.

Due to onset of a major recession, growth in Northern Virginia slowed remarkably in the early 1990s. UOSA, with the concurrence of its four member jurisdictions, decided to hold off proceeding with the construction of the main portions of the then-designed Project 54 plant expansion project until the long-term treatment capacity growth needs of the member jurisdictions could be better predicted with greater certainty. However, the need for additional short-term treatment capacity required to bridge the time period when the entire Project 54 treatment facilities could be made available still existed. Therefore, CH2M HILL was authorized in 1992 to finalize the design of the necessary treatment plant facilities to achieve an interim plant treatment capacity of 32 mgd (maximum 30-day flow) as well as prepare the plant site for future Project 54 construction. The total construction cost of this work was approximately $38 million and took 3 years between 1993 and 1996 to construct. CH2M HILL provided all permitting assistance, design and construction inspection, and administration services required to facilitate project completion.

During the Project 32 construction time period, the country and the Northern Virginia area worked itself out of its economic doldrums; and rapid growth resumed in UOSA's service area. As a result, UOSA's four member jurisdictions in 1995 again approved proceeding with the design and constructing the remaining major portions of its treatment plant, which would result in doubling the size of UOSA's water reclamation plant to 54 mgd. During the early 1990s delay period, UOSA took this opportunity to conduct numerous pilot studies with the assistance of CH2M HILL to determine ways to improve the performance and simplify the maintainability of several of the AWT unit processes of the plant.

At UOSA's request, Suhr again moved to Virginia to lead the design effort. UOSA created an office for him at its headquarters building to maximize coordination of the design effort between UOSA and CH2M HILL staff. In the words of Executive Director Robbins, "that was the best decision I ever made!...It shaved months and thousands of dollars off the project." The Project 54 design was completed in 1996; and a single $200 million, 4-year construction contract was awarded in late 1996. Major plant construction was ultimately completed in 2004.

Gene Suhr and Millard Robbins

The 1987 PER also outlined a number of other companion UOSA collection system projects

required to keep pace with the rapid growth in sewage flows. Several pump station and force main improvements have been completed and more are still ongoing to complete the infrastructure for Project 54. When complete, Project 54 will have taken over 25 years to complete with CH2M HILL engaged every step of the way. As soon as Project 54 was complete, UOSA once again began planning for the future. While growth in UOSA's member jurisdiction Fairfax County has slowed as they reach buildout, Prince William County is now the rapid growth center for the watershed; and the protection of the Occoquan Reservoir is still the prime mission of UOSA. In addition, UOSA is now faced with an aging infrastructure and increasing regulatory demands driven by protection of the Chesapeake Bay. In October 2007, CH2M HILL was once again selected to aid UOSA with a new Capital Improvement Program (CIP) to address these developing issues. As of 2011, CH2M HILL has assisted UOSA with the development of the CIP, which acts as a road map for the coming years and has produced a number of designs to enhance the infrastructure at its water reclamation plant. The construction of these improvements continue today (2011) with current projected CIP capital costs exceeding $375 million.

CH2M HILL has been UOSA's prime engineering consultant since its formation in 1971, and we look forward to designing and administering the construction of upcoming projects and being of continued service to this most valued and outstanding client for years to come. UOSA is a symbol of CH2M HILL's commitment to client service, technology, and our entry onto the national (and international) stage as a premiere engineering services provider.

The testimony to UOSA that signifies its success is that today UOSA discharges an average flow of approximately 30 mgd with levels of contaminants orders of magnitude less than the combined constituents of the original 11 treatment plants in 1970 discharging only 3 mgd at the time. UOSA's effluent has gone from an environmental concern to a valued resource in the community protecting the drinking water supply, offsetting the impacts of nonpoint source contaminants associated with urban development, and actually increasing the safe yield of the Occoquan Reservoir to allow further growth and prosperity for the region.

Millard Robbins

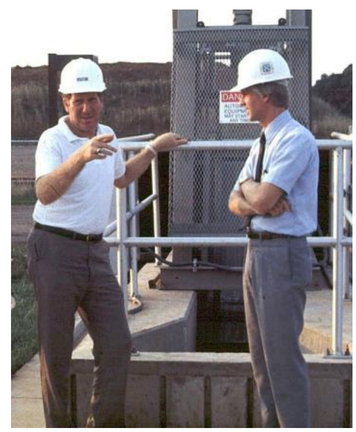
Any recounting of the story of the UOSA would be incomplete without mentioning the role that has been played by the authority's first executive director. Millard Robbins, Jr. served in that role continuously from 1974 through 2000. Prior to his selection as executive director, he was involved in promulgation of the Occoquan Policy and review of the original PER as an engineer on the SWCB staff. UOSA's directors have fittingly recognized his leadership by naming the present facility the Millard H. Robbins, Jr. Regional Water Reclamation Plant. At the ceremony honoring Robbins, numerous CH2Mers were present including the now retired original odd couple, Harlan and Gene, as well as George Gunn, who supervised both construction and project delivery phase services of every UOSA project from 1973 to the present.

The UOSA Story would also not be complete without mentioning the four decades of CH2M HILL engineers that have served the client and the firm with high distinction.

Original Proposal and Interview Team: Harlan Moyer, Gene Suhr, Sid Lasswell.

Original Design and Construction Team (Project 15): Harlan Moyer, Gene Suhr, Larry Kepple, Dana Rippon, Bob Chapman, Ray Prettyman, Howard Wilson, Sam and Stan Smith, Wayne Riggins, Don Evans, Ed Prestemon, and George Gunn.

Subsequent Expansions (Project 27, Contract 32, and Project 54): Ed Prestemon, Tim Gallagher, George Gunn, Glenn Palen, Tim Hall, Gene Suhr, Mark Yoder, Mark Osborne, Keith Damkot, and Don Forgacs.



George Gunn with Ed Prestemon

Ongoing Capital Improvement Program Team: Tim Gallagher, Ed Fleisher, Don Forgacs, Phil Dowd, Bruce Mattheiss, and George Gunn.

Without their dedication and strong commitment to meeting the needs of UOSA, there would be no UOSA Story to tell.