PIMA COUNTY REGIONAL WASTEWATER RECLAMATION DEPARTMENT

PROJECT: DESIGN ENGINEERING SERVICES FOR THE INA ROAD WPCF CAPACITY AND EFFLUENT QUALITY UPGRADE

CONSULTANT: CH2M HILL, Inc.
2625 South Plaza Drive, Suite 300
Tempe, AZ 85282

CONTRACT NO.: 16-03-C-140877-0208

AMENDMENT NO.: Five (5)
FUNDING: 2004 Bond Funds and Future Bond Issues

CONTRACT
NO. 16-03-C-140877-0208
AMENDMENT NO. 05
This number must appear on all invoices, correspondence and documents pertaining to this contract.

CONTRACT TERM: 02/05/08 - 02/04/10	**ORIGINAL CONTRACT AMOUNT:**	$ 18,000,000.00
TERMINATION PRIOR AMENDMENT: N/A	**PRIOR AMENDMENT(S):**	$ -
TERMINATION THIS AMENDMENT: N/A	**AMOUNT THIS AMENDMENT:**	$ 599,499.00
	REVISED CONTRACT AMOUNT:	$ 18,599,499.00

CONTRACT AMENDMENT

WHEREAS, COUNTY and CONSULTANT have entered into the Contract referenced above dated February 5, 2008; for professional engineering design services; and

WHEREAS, COUNTY wishes to merge other Ina Road WRF CIP projects into one design effort to increase consistency of design and improve project efficiency; and

WHEREAS, COUNTY now requires additional design services to incorporate Headworks equipment and Odor Control design, the design of a new Electrical Switchgear Building required for the Ina Road WRF expansion, and to provide for related additional laboratory testing to support these design efforts; and

WHEREAS, CONSULTANT is qualified to provide these design services and has proposed pricing acceptable to COUNTY for theses services; and

WHEREAS, the parties agree to amend the contract accordingly.

NOW, THEREFORE, it is agreed as follows:

CHANGE: ARTICLE IV – PAYMENT, third paragraph,

From: "The total of all payments to DP for services provided under this Contract shall not exceed Eighteen Million Dollars ($18,000,000.00) unless otherwise agreed to by OWNER."

To: "The total of all payments to DP for services provided under this Contract shall not exceed Eighteen Million Five Hundred Ninety Nine Thousand Four Hundred Ninety Nine Dollars ($18,599,499.00) unless otherwise agreed to by OWNER."

ADD: To EXHIBT "A" - SCOPE OF WORK, ATTACHMENT 1 TO EXHIBIT "A" (34 pages attached)

REPLACE: APPENDIX "B" Section I. COMPENSATION SCHEDULE – COST PLUS FIXED FEE, NOT TO EXCEED (Rev. Nov. 2, 2009) (2 pages attached)

WITH: APPENDIX "B" Section I. COMPENSATION SCHEDULE – COST PLUS FIXED FEE, NOT TO EXCEED (Rev. 12/07/09 (4 pages attached)

This Amendment shall be effective retroactive to September 1, 2009.

All other provisions of the Contract, not specifically changed by this amendment, shall remain in effect and be binding upon the parties.

C

IN WITNESS THEREOF, the parties have affixed their signatures to this amendment on the dates written below.

APPROVED:

Chair, Board of Supervisors

DEC 15 2009
Date

CONSULTANT:

Signature

George A. Gunn, V.P.
Name and Title (Please Print)

12-29-09
Date

ATTEST:

Clerk of the Board

APPROVED AS TO FORM:

Deputy County Attorney

12-9-09
Date

Pima County Regional Wastewater Reclamation Department

Ina Road WRF Capacity and Effluent Quality Upgrade Project

Headworks Equipment Replacement and Odor Control

Change Order No. 6

PROJECT DESCRIPTION

This work includes existing Headworks coarse screen replacement and grit classifier replacement. It also includes evaluation and design of modifications to the Headworks ventilation and odor control systems to improve odor control and operating conditions within the Headworks building spaces. The odor control work will include enclosing process equipment and channels for separation of internal odor sources from work zone building spaces. Additional odor control needs, outside the Headworks, including evaluation of the odor control requirements for the last portion of the Plant Interconnect, have also been identified and will be included in Headworks odor control system requirements. A recommended approach for equipment replacement, odor control, and ventilation will be developed and incorporated into the Ina Road WRF Upgrade Project contract documents.

SCOPE OF WORK

Task 1 Project Kick-off Meeting and Workshop

The primary purpose of this task is to discuss and finalize the overall project objectives related to Headworks equipment replacement, improving worker comfort and safety within the Headworks, mitigating offsite odor impacts associated with the Headworks facilities and eliminating the requirement for the use of the chemical scrubbers to meet the site wide odor control criterion. Topics to be discussed will include:

- Replacement sequence of the two existing coarse screens. A new third screen will be added to the bypass channel as a part of the original Upgrade Project scope.
- Replacement sequence of the three existing grit classifiers.
- Enclosures/covers needed to separate process-related foul air (FA) from general room air.
- Ventilation rates needed at process-related FA pickups to mitigate FA escape from processes during normal operation (e.g., covers/enclosures in place).
- Ventilation rates for general room air including NFPA 820 requirements.
- Evaluation of the potential to treat process-related FA using first-stage biotowers followed by second-stage activated carbon.

- Evaluation of the potential of utilizing the existing chemical scrubber vessel for the process-related FA treatment. Determination if the residence time in the existing vessel is adequate.
- Inspection and evaluation of the existing FRP scrubbers and ductwork.
- Evaluation of the potential to treat general room air by activated carbon (bypassing first-stage biotowers).
- Evaluation of the odor control system requirements, if the room air and the process air are not separated, and a two-stage odor system is required to meeting the treatment requirements.
- Discussion of the new odor control system that will serve the new plant interconnect (e.g., size, technology, and location).
- Control strategies for operating separate FA and general room ventilation exhaust streams.

Deliverables

The primary deliverable of Task 1 will be a Technical Memorandum that documents the conclusions and agreed-to direction for Headworks equipment replacement, odor control and building ventilation improvements. Design criteria and basis of information to be used during Task 2 Schematic Design will also be documented.

Task 2 Schematic Design

Based on the direction of the project established during Task 1, schematic design will be completed to take the design to a 30% level. In addition to this work associated with the Headworks, preliminary design information for the new odor control system that will be constructed to treat the plant interconnect will be included.

Work products to be completed during Task 2 will include:

- Equipment replacement drawings.
- Drawings depicting the extent of the enclosures/covers needed to separate process air from general room air on existing equipment.
- Drawings showing ductwork modifications (e.g., new ductwork or existing ductwork modification).
- Process flow diagram.
- Dispersion modeling of the site with the addition of the plant interconnect odor source.
- Process and Instrumentation diagram.
- Cost estimate.

As part of Task 2, draft work products will be submitted to PCRWRD for review. A review meeting will be held with PCRWRD to discuss the drawings/cost estimate. Based on this meeting, CH2M HILL will revise the information and incorporate it into the Ina Rd WRF Upgrade Project.

Deliverables

- Design Memorandum including design criteria, proposed system, process descriptions and modeling results.
- Drawings showing new screen and grit equipment, enclosures/covers and ductwork modifications.
- Drawings showing layout and general arrangement of the Plant Interconnect odor control system.
- P&IDs.
- Process Flow Diagrams.
- Preliminary Cost Estimate.

Task 3 Final Design

In this task, the final design of these facilities will be completed as a part of the Ina Road WRF Capacity and Effluent Quality Upgrade project. Intermediate design documents will be submitted at the 60% and 95% completion phases of the Upgrade project.

SCHEDULE

The Task 1 Design Memorandum would be delivered 30 calendar days from the Notice to Proceed. Tasks 2, and 3 will be incorporated into the current Capacity and Effluent Quality Upgrade Project schedule.

COMPENSATION

The budget for this task is based on Attachment 1.

EXHIBIT B

CIJD for Change Item CI-006/CH2M-CR-009

Pima County Regional Wastewater Reclamation Department

Ina Road WRF Capacity and Effluent Quality Upgrade Project

New Switchgear Building

Change Order No. 9

July 27, 2009

PROJECT DESCRIPTION

This scope of work describes the services to be provided by CH2M HILL, the Design Professional (DP) for the design of a new medium voltage switchgear building at the Ina Road Wastewater Reclamation Facility (Ina Road WRF) for the Capacity and Effluent Quality Upgrade Project (Upgrade Project). The key components of the facility are generally described as follows:

- Design and specification of medium voltage metal clad switchgear which will serve as the central point of primary power distribution throughout the Ina Road WRF site.
- Design of the building and ancillary systems to house the electrical equipment described above.
- Design of the following:
  - circuit breakers for connection to Tucson Electric Power (TEP), as well as the existing and proposed Energy Recovery Facility (ERF).
  - instrumentation and protective relaying for external utility and generation sources.
  - controls, including SCADA interconnections.

This change order does not include:

- Work related to improvements of the existing on-site power generation system.
- Design of site power distribution systems, which is part of the Upgrade Project.
- Design of interconnection with TEP, the existing ERF, or the proposed new ERF; however, the building will include provisions for connections to these systems and facilities as these are part of the Upgrade project or the ERF contractor will make the connection.
- SCADA software and programming to be provided by others.
- Excavations or other mitigation measures required to preserve or relocate historic resources.
- Fees associated with required permits.

- A value engineering task to evaluate multiple design options.

The following key assumptions were made in the development of the Scope of Work for design and in estimating level of effort:

- Pima County Regional Wastewater Reclamation Department (PCRWRD or OWNER) will facilitate communication with TEP, as needed, to obtain necessary information for the switchgear design. Information needed from TEP includes:
  - available fault current at the Ina Road site.
  - TEP requirements for instrumentation, relaying, and control for interconnection of user-owned generation facilities
- The new switchgear building will include no provisions for a control room for the proposed ERF.
- With the exception of the final review, the DP will continue the design effort during formal reviews of deliverables by PCRWRD and regulatory agencies.
- The design will be based on the federal, state, and local codes and standards in effect at the start of the project.

The construction documents for the switchgear building will be included in the Upgrade Project construction contract package. The design will be carried out using a five-phased design delivery approach:

1. Preliminary Design Workshop (10%)
2. Schematic Design (30%)
3. Design Development (60%)
4. Contract Document Development (95%)
5. Contract Document Completion (100%)

Each phase will have a specific list of work products and deliverables. Also, each phase will include design review workshops with PCRWRD's and DP's personnel at critical design milestones. Deliverables for 60%, 95%, and 100% will be incorporated into the Upgrade Project deliverables.

SCOPE OF WORK

Project Management

Management activities for this Change Order will be incorporated in the overall project management activities of the Upgrade Project.

Task 1 Preliminary Design

The purpose of this task is to take the concepts from a PCRWRD meeting held on June 9, 2009 and prepare updated design criteria for use in the design phases. The following tasks will be completed for the Preliminary Design phase of this task:

- Perform data and information collection.

- Conduct preliminary process design for new switchgear building.
- Develop Preliminary Design (10%) Report for a new switchgear building.
- Identify utility conflicts within the construction area.
- Identify other potential conflicts to design or construction of the new switchgear building.

A workshop will be conducted during this phase to obtain PCRWRD and Construction Manager at Risk (CMAR) input and recommendations. Following that workshop, PCRWRD and CMAR comments and recommendations will be captured in meeting minutes. The design of the facility, as influenced by input gathered at the workshop, will serve as the basis for the Schematic Design.

Deliverable	Quantity	Comments
Workshop Minutes	1 electronic copy	
Preliminary Design Report – New Switchgear Building	6 – Hard copies and 1 electronic pdf format copy	Design memoranda

Task 2 Schematic Design

The purpose of this task is to develop the concepts established in the Preliminary Design phase to an approximate 30% Schematic design level. Schematic Design will further define the facilities and equipment requirements required for the switchgear facility. The following tasks, related to the new switchgear building, will be completed for the Schematic Design phase of this task:

- Prepare 30% design model.
- Design the new switchgear and building to the 30% design stage.
- Confirm Cultural Resource Clearance with Pima County Cultural Resources and Historic Prevention Office.
- Conduct workshop with Ina Road WRF management and operations staff to obtain input to the switchgear building design prior to submittal of the Schematic Design Report.
- Complete the Schematic Design Report.
- Prepare the 30% construction cost estimate for the new switchgear building.

Incorporate the switchgear construction into the maintenance of plant operations (MOPO) plan for the project. Deliverables for the schematic design phase are:

Deliverable	Quantity	Comments
30% Schematic Design Report – New Switchgear Building	6 – Hard copies and 1 electronic pdf format copy	Preliminary drawings and design memoranda
30% Construction Cost Estimate - Switchgear Building	1 - Electronic pdf copy	

Task 3 Design Development

The purpose of this task is to further develop the design to an approximate 60% level, to facilitate CMAR coordination and understanding of the design, and to develop a 60% construction estimate for the switchgear facility. The following tasks will be completed during this phase:

- Update the 60% construction cost estimate for the new switchgear building. Develop switchgear facility drawings, including: partial plan, partial sections, lighting layouts, detailed diagrams and schedules, and demolition details consistent with a 60% design.
- Conduct workshop with Ina Road Operation's staff to receive comments on the 60% new switchgear building design.

Deliverables for the design development phase are:

Deliverable	Quantity	Comments
60% Design Development Documents	per Upgrade Project	Incorporates OWNER adjudicated comments and recommendations from 30%Drawings and switchgear building and equipment specifications will be included in the Upgrade Project 60% Design Development Report.
60% Construction Cost Estimate	per Upgrade Project	Will be included in the 60% Upgrade Project cost estimate.

Task 4 Contract Document Preparation

The purpose of this task is to further develop the design to a level ready for sealing and signing, with final agency and OWNER review outstanding. The following tasks will be completed for the Contract Document Preparation (95%) phase of the new switchgear building design:

- Provide 95% construction cost estimate for the new switchgear building. Complete the design of the new switchgear building including plans and specifications ready to be sealed and signed.
- Provide affected agencies with plans for review and final comments.

Deliverables for the contract document preparation phase are:

Deliverable	Quantity	Comments
95% Contract Documents	per Upgrade Project	Drawings and specifications will be included in the Upgrade Project documents. Incorporates OWNER adjudicated comments and recommendations from 60%
95% Construction Cost Estimate	per Upgrade Project	Will be included in the 95% Upgrade Project cost estimate.

Task 5 Final Contract Documents

The purpose of this task is to incorporate any final agency and OWNER adjudicated comments into the design, complete the design, and produce sealed and signed documents ready for construction. The following tasks will be completed for the Final Contract Documents (100%) phase of this subtask for the new switchgear building:

- Complete the 100% design of the project including signed and sealed drawings and specifications needed for construction for submission to the OWNER and CMAR.

Deliverables for the final contract document preparation phase are the 100% Contract Documents, incorporating OWNER adjudicated comments and recommendations from 95%.

Deliverable	Quantity	Comments
100% Contract Documents	per Upgrade Project	Drawings and specifications will be included in the Upgrade Project 100% contract documents.

Schedule

Tasks 1 and 2 presented in this scope of work will be completed in 13 weeks from Notice to Proceed. It is anticipated that Tasks 3, 4, and 5 will be incorporated into the overall Upgrade schedule by the 95% Upgrade submittal.

Compensation

The budget for Change Order No. 9 is based on Attachment No. 1.

EXHIBIT C
Tasks and Deliverables for Additional Services

CI-003/CH2M-CR-006 – Additional Headworks Equipment Replacement and Odor Control Design	
Deliverable	**Quantity**
Task 1 – Project Kick-Off Meeting and Workshop	
Draft Technical Memorandum to Document Agreed-To Direction for Design	One Electronic Copy to PM/CI for Distribution. Six Paper Copies to PM/CI for File/Distribution.
Final Technical Memorandum to Document Agreed To Direction for Design	One Electronic Copy to PM/CI for Distribution. Six Paper Copies to PM/CI for File/Distribution.
Task 2 – Schematic Design	
Draft 30% Design Memorandum	One Electronic Copy to PM/CI for Distribution. Six Paper Copies to PM/CI for File/Distribution.
Draft 30% Design Drawing	One Electronic Copy to PM/CI for Distribution. Six Paper Copies to PM/CI for File/Distribution.
Draft 30% Cost Estimate	One Electronic Copy to PM/CI for Distribution. Six Paper Copies to PM/CI for File/Distribution.
Final 30% Design Memorandum	One Electronic Copy to PM/CI for Distribution. One Paper Copies to PM/CI for File/Distribution.
Final 30% Design Drawing	One Electronic Copy to PM/CI for Distribution. Six Paper Copies to PM/CI for File/Distribution.
Final 30% Cost Estimate	One Electronic Copy to PM/CI for Distribution. Six Paper Copies to PM/CI for File/Distribution.
Task 3 – Final Design	
To be part of submittals for the total Upgrade Project. Design Development (60% Design), Construction Documents (95% Design), and Construction Documents (100% Design) also to be part of total Upgrade Project.	

CI-006/CH2M-CR-009 – New Switchgear Building Design	
Deliverable	**Quantity**
Task 1 – Preliminary Design	
Workshop Minutes	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Draft Preliminary Design Report	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Final Preliminary Design Report	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Task 2 – Schematic Design	
Draft 30% Schematic Design Report (Preliminary Drawings and Design Memoranda)	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Draft 30% Construction Cost Estimate	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Final 30% Schematic Design Report (Preliminary Drawings and Design Memoranda)	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Final 30% Construction Cost Estimate	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Task 3 – Design Development	
60% Design Documents	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
60% Construction Cost Estimate	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
60% Design Workshop	-
60% Design Workshop Minutes	One Electronic Copy to PM/CI for Distribution. Six Paper Copy to PM/CI for Paper File.
Task 4 – Contract Document Preparation	
To be part of submittals for the total Upgrade Project.	
Task 5 – Final Contract Documents	
To be part of submittals for the total Upgrade Project.	

WET Testing and Disinfection By Product (DBP) Formation Bench Testing	
Deliverable	**Quantity**
WET Testing	
As Defined in Exhibit F	As Defined in Exhibit F
Disinfection By Product (DBP) Formation Bench Testing	
As defined in Exhibit F	As Defined in Exhibit F

EXHIBIT D
Compensation Schedule for Additional Services

CI-003/CH2M-CR-006 – Additional Headworks Equipment Replacement and Odor Control Design	
Pay Item	**Budget/Payment, $s**
Task 1 (Note 1)	14,200.00
Task 2 (Note 1)	38,000.00
Task 3 (Note 1)	164,000.00
Subtotal	**216,200.00**
Fixed Fee Task 1 (Note 2)	1,830.00
Fixed Fee Task 2 (Note 2)	4,880.00
Fixed Fee Task 3 (Note 2)	21,090.00
Subtotal	**27,800.00**
Total	**244,000.00**
Notes: 1. Payment on an actual cost basis each pay period up to the budget amount. 2. Payable in full at completion of task.	

CI-006/CH2M-CR-009 – New Switchgear Building Design	
Pay Item / Project Number	**Budget/Payment, $s**
Task 1 (Note 1)	23,500.00
Task 2 (Note 1)	61,800.00
Task 3 (Note 1)	94,500.00
Task 4 (Note 1)	84,400.00
Task 5 (Note 1)	35,899.00
Subtotal	**300,099.00**
Fixed Fee Task 1 (Note 2)	2,700.00
Fixed Fee Task 2 (Note 2)	7,100.00
Fixed Fee Task 3 (Note 2)	10,900.00
Fixed Fee Task 4 (Note 2)	9,700.00
Fixed Fee Task 5 (Note 2)	4,100.00
Subtotal	**34,500.00**
Totals	**334,599.00**
Notes: 1. Payment on an actual cost basis each pay period up to the budget amount. 2. Payable in full at completion of task.	

WET Testing and Disinfection By Product (DBP) Formation Bench Testing	
Pay Item / Project Number	**Budget/Payment, $s**
WET Testing	2,500.00
DBP Formation Bench Testing	18,400.00
Totals	**20,900.00**

EXHIBIT E
Distribution of Amendment Three Budget According To PCRWRD Project Number

Project Number	Project Name	Budget Amount, $s	Comments
3IRS01	Coarse Screen Replacement	42,735	
	Grit Classifying Equipment Replacement	42,735	
3RIR04	Odor Control at Headworks	158,530	
3RIR03	New Switchgear Building	334,599.00	
	WET and DBP Formation Bench Scale Testing	20,900.00	
	Total	**599,499.00**	

EXHIBIT F

Justification Documents for WET Testing and Disinfection By Products (DBP) Formation Bench Testing (20 Pages)

JACOBS

Jacobs Field Services North America
c/o Ina Road Water Reclamation Facility
4963 W. Ina Rd.
Tucson, AZ 85743

October 9, 2009

Mandley Rust
Project Manager
PIMA County RWRD
7101 N. Casa Grande Hwy.
Tucson, AZ 85743

RE: INA ROAD WRF
Contract: 1603C140877
Laboratory Testing

Dear Mr. Rust,

In an October 1, 2009 meeting with CH2MHill, Pima County, and Jacobs, the team determined that CH2MHill's laboratory would perform both Whole Effluent Toxicity (WET) testing of two effluent samples, along with bench testing of Disinfection Byproduct (DBP) formation on secondary clarifier effluent. The WET testing is required to confirm that the plant effluent does not violate discharge standards. The DBP testing will measure the formation potential of trihalomethanes (THM's) and NDMA. These tests are required to confirm that the planned disinfection process will meet effluent discharge standards for THM's and NDMA. This data is required to obtain the aquifer protection permit for the upgraded plant.

CH2MHill submitted a cost proposal of $2,500 for the WET testing. In addition, CH2MHill submitted a cost proposal of $18,400 for the DBP testing. Jacobs reviewed these cost proposals and believes the pricing is reasonable. Jacobs recommends incorporating these items into a contract amendment for CH2MHill to perform laboratory testing. The total cost of the laboratory testing is $20,900. Copies of CH2MHill's proposals and back-up information are attached.

Sincerely,

Mike Di Napoli

Mike A. DiNapoli
Project Manager

Attachment:

Cc: Larry J Oliver (Jacobs Field Services of North Ameri), Ron F. Cilensek (Jacobs Field Services of North Ameri), Kathy Klingler (Jacobs Field Services of North Ameri), Mike A. DiNapoli (Jacobs Field Services of North Ameri), Bobby DeAngelo (PIMA County RWRD), Rizzalyn V Olsen (PIMA County RWRD)

CH2MHILL
Applied Sciences Laboratory (ASL)

2300 NW Walnut Blvd
Corvallis, OR
97330-3538
Tel 541.752.4271
Fax 541.752.0276

QUOTATION

Pima County WWR
7101 N. Casa Grande Highway
Tucson AZ 85743

Quotation Date: 10/02/09
Quotation No.: Q09-02333

Attention: Tom Berry

Project ID:374210.IR.02	Expires: 12/31/2009	Prepared By:

Qty	Description	Unit Cost	Subtotal
2	*Ceriodapnia dubia* chronic, definitive, bioassay	$1,250.00	$2,500.00

Quote Total: $2,500.00

Shipping: Preserved sample bottles with chain of custodies and cooler are provided in the analytical cost. All shipments are sent by ground shipment. Priority shipment is the responsibility of the client. Client is responsible for return shipment to the laboratory unless otherwise pre-arranged as indicated in the Statement of Work. Client owned coolers will be returned at cost to client by ground shipment.

Payment: Prices are firm for 90 days. All work requires submission of a valid purchase order or credit card and is subject to CH2M HILL INC standard terms (net 30 days) and conditions. Late payment fees of 1.5% month will be imposed on balances past due. Field QC and field specified sample matrix QC are billable samples.

Submitted by:_____

Acceptance by:_____

CH2MHILL
Applied Sciences Laboratory (ASL)

2300 NW Walnut Blvd
Corvallis, OR
97330-3538
Tel 541.752.4271
Fax 541.752.0276

QUOTATION

Additional Terms and Conditions

1. **Minimum Transaction Fee** - CH2M HILL ASL's minimum invoice is $100 per batch of samples logged in together.
2. **Matrix Spike/Spike Duplicate Samples** - Any requested MS/MSD will be charged at unit rates. Additional sample volume may be required for MS/MSD analyses.
3. **Final Reports** - CH2M HILL ASL submits all reports as a PDF report that are emailed to the client.
4. **Deliverables** - CH2M HILL Level 2 reports will be provided unless specifically stated on the quote.
5. **EDD** - EDD can be provided if requested and indicated on the quote. EDD will be provided using Lab Spec 7 Format. Additional EDD formats are available and may be charged a setup fee.
6. **Expedited Turnaround Times** - this may be available and must be pre-approved by the laboratory. Surcharge fees are:

   <24 hour TAT x3.0
   24 hour TAT x2.5
   2 business day TAT x2.0
   3 business day TAT x1.85
   5 business day TAT x1.7
   7 business day TAT x1.5
   10 business day TAT x1.25

7. **Supplies and Coolers** - CH2M HILL ASL will supply sample bottles and coolers to support analytical testing. The cost of these supplies are included in the analytical price. Coolers not returned will be charged a $40 per cooler fee. In addition, if 80% of the quoted samples are not returned, bottles will be charged back to the client.
8. **Sample Containers and shipping** - All shipments by CH2M HILL ASL are shipped by Ground shipment at no additional charge to the client. A minimum of 7 business days advance notice is required in order to ship Ground. Shipments requiring priority or air shipment shall be charged to the client at CH2M HILL's rate or on client's shipping account.
9. **Limits/QC** - this quotation is based on standard deliverables (RLs, QC and compound lists) unless otherwise indicated by a project QAPP/SOW.
10. **Modifications** - If a sample received is of unknown character than originally quoted, client will be promptly notified. An amended quote will be prepared and upon agreement the sample shall be deemed to have been received.
11. **Turn around Time** - Samples received after 1500 will be logged in as the following business day. Quick turnaround times are available at a premium cost which will be defined in the quote, provided that the lab has capacity.
12. **Retention or Reports** - CH2M HILL ASL shall retain copies of analytical reports for a period of 7 years after report date. If client requests additional copies of reports during this retention time, an additional cost will apply for the preparation, printing and retrieving of such reports.
13. **Sample Disposal/Storage** - Samples will be disposed at no additional cost to clients, 30 days after the final report is issued. Storage of samples and containers beyond this may be available for an additional fee. Samples classed as hazardous based on hazardous waste regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA) and 40CFR, will either be returned to client at the client's expense or the client will be charged a $5 per sample disposal fee.

CH2M HILL
2625 S. Plaza Drive
Suite 300
Tempe, AZ 85282-3397
Tel 480.966.8188
Fax 480.966.9450

CH2MHILL

October 7, 2009

Mr. Mike DiNapoli
Jacobs
c/o Ina Road Water Reclamation Facility
4963 W. Ina Road
Tucson, AZ 85743

Subject: Contract No. 16-03-C-140877-0208
Ina Road WRF - Effluent Chlorination and Sequential Chloramination (including DBPs) Testing

Based on discussions in the WET Testing and Disinfection meeting, held October 1, 2009, PCRWRD staff requested a cost for having the CH2M HILL Applied Sciences Laboratory perform the testing described in the attached memo, Disinfection Byproducts with Free and Sequential Chlorination, dated September 17, 2009.

The CH2M HILL laboratory testing cost includes:

- effluent sample characterization
- free chlorine batch testing
- sequential chlorination batch testing
- shipping costs

Sample containers, as well as, sample preservation and shipping instructions will be provided. The tabulated results will be provided to the PCRWRD and to the design team.

Costs for the work described above and in the attached memorandum are estimated to be $18,400. Please contact me at 520.547.9640 or 480.205.1763 should you have any questions.

Sincerely,

CH2M HILL

Ronald E. Williams

Ronald E. Williams, P.E.
Senior Project Manager

Enclosure

C: Mr. Mandley Rust, P.E., PCRWRD
Mr. Larry Oliver, P.E., Jacobs
Mr. Jeff Prevat, PCRWRD

MEMORANDUM **CH2MHILL**

Ina Road Wastewater Reclamation Facility Capacity and Effluent Quality Upgrade

Disinfection Byproducts with Free and Sequential Chlorination

PREPARED FOR:	Pima County Regional Wastewater Reclamation Department
PREPARED BY:	Todd Greeley/CH2M HILL
REVIEWED BY:	Barb Engleson/CH2M HILL, Larry Schimmoller/CH2M HILL
DATE:	September 17, 2009
PROJECT NUMBER:	374210

Purpose

The purpose of this investigation is to determine the formation of Trihalomethanes (THMs) and N-Nitrosodimethylamine (NDMA) from disinfection of Ina Road Wastewater Reclamation Facility secondary effluent (East Plant) with free chlorine or the sequential use of free and combined chlorine. THMs and NDMA are regulated disinfection byproducts (DBPs) and the Capacity and Effluent Quality Upgrade project (Upgrade Project) must include a disinfection system that meets effluent requirements. This memorandum describes disinfection with sequential chlorination and includes preliminary protocols for bench scale tests of DBP formation.

The Regional Optimization Master Plan (ROMP) recommended enhanced chlorination for the Upgrade Project based upon the Enhanced Chlorination Study which looked at *E. coli* inactivation with free chlorine. The follow-up Disinfection Byproduct Investigation, conducted during May 2009, concluded that the use of enhanced chlorination would not consistently produce effluent within regulatory limits for THMs during minimum flows with a chlorine residual of 3 mg/L. Combined chlorine was suggested as an alternative that produces fewer THMs than free chlorine, but increases formation of NDMA and is a less powerful disinfectant. The two disinfectants can be used sequentially to moderate production of THMs and NDMA while maintaining higher disinfection than chloramines alone.

This investigation will examine THM and NDMA production from free chlorination and sequential chlorination. The tests will explore DBP formation and disinfection at a range of free chlorine doses to assess the adequacy of these strategies for meeting effluent quality regulations. Further tests may be needed to optimize chemical doses and locations.

Regulations

The Upgrade Project limits for total coliform, *E. coli*, and fecal coliform are directed by the Aquifer Protection Permit Program. These limits are presented in Table 1.

Total THMs are limited to <0.1 mg/L by the Aquifer Water Quality Standards with a future limit of 0.08 mg/L. The current "alert limit" for TTHMs is 0.08 mg/L and will likely be 0.06 mg/L in the future. NDMA was recently limited to 30 ng/L by the Partial Body Contact criterion of the Surface Water Quality Standards. The Disinfection Byproduct Investigation memorandum from March 30, 2009 contains more discussion of regulatory limits on DBPs.

TABLE 1
Effluent Quality Requirements
Combined Chlorine Disinfection Investigation

	Units	Regulatory Limit
Total Coliform		
Total	cfu / 100 mL	23
Fecal Coliform		
4 out of 7 samples	cfu / 100 mL	Nondetect
Single sample maximum	cfu / 100 mL	<23
E. Coli		
4 out of 7 samples	cfu / 100 mL	Nondetect
Single sample maximum	cfu / 100 mL	<15
Trihalomethanes		
Total, single sample maximum	ug/L	100 (80 future)
N-Nitrosodimethylamine		
Single sample maximum	ng/L	30

Background

Disinfection Byproducts

Free chlorine is very reactive and will rapidly both disinfect and produce THMs. If ammonia is present when chlorine is added, chloramines are preferentially formed before the free chlorine reacts with organic nitrogen or other compounds. Chloramines are disinfectants with low THM production but they can cause NDMA formation.

Combined Chlorine

Chloramines, also known as combined chlorine, consist of monochloramine, dichloramine, and trichloramine. Free chlorine and ammonia react to form chloramines in the following reactions:

Monochloramine reaction: $NH_3 + HOCl \rightarrow NH_2Cl + H_2O$ (1)

Dichloramine: $NH_2Cl + HOCl \rightarrow NHCl_2 + H_2O$ (2)

Trichloramine: $NHCl_2 + HOCl \rightarrow NCl_3 + H_2O$ (3)

The chloramine reactions are dependent on both the free chlorine to ammonia ratio and the pH.

Breakpoint Reaction

Addition of chlorine in excess of a 5: 1 weight ratio with ammonia-nitrogen causes the destruction of both free chlorine and ammonia. At a ratio of approximately 7.6 : 1 all free chlorine and ammonia-nitrogen are consumed without providing disinfection. This "breakpoint" occurs through the following net reaction:

$$NH_4^+ + 1.5HOCl \rightarrow 0.5N_2 + 1.5\ H_2O + 2.5H^+ + 1.5Cl^-$$

At ratios less than 7.6 : 1 of chlorine to ammonia-nitrogen, chlorine residual is in the form of chloramines. At ratios greater than 7.6 : 1 of chlorine to ammonia-nitrogen, chlorine residual is in the form of free chlorine and all ammonia is removed as nitrogen gas.

Sequential Chlorination

Sequential chlorination divides the disinfection process into two phases. The first phase uses free chlorine to disinfect at a high rate for a short period. If the wastewater contains any ammonia, sufficient chlorine must be added both to remove the ammonia through the breakpoint reaction and to provide disinfection with free chlorine. The majority of free chlorine in the wastewater at the end of the first phase should be consumed. During this phase THMs are produced, but the low chlorine dose and short contact time should moderate formation.

For the second phase, preformed monochloramine is applied to continue disinfection. Preforming chloramines allows the exclusive production of monochloramines, which form NDMA less rapidly than dichloramine. This moderates NDMA production and eliminates THM formation. Disinfection occurs at a slower rate than in the first phase but there is a longer contact time.

Studies

Two sets of batch tests are recommended to assess DBP formation with free chlorination and sequential chlorination. Collection of fullscale data is also requested to support design of the disinfection system.

Free chlorine batch tests

The first set of batch tests determines DBP formation and pathogen inactivation with various doses of free chlorine on a single secondary effluent sample collected from the East Plant. These batch tests are described in detail in Appendix A, Free Chlorine Batch Tests.

The secondary effluent sample is first characterized. Ammonia is measured to determine any additional chlorine needed to reach breakpoint. Background levels of THM, NDMA, *E.*

coli, total coliform, and UV-254 absorption will be measured. This secondary effluent sample will be used for all free and sequential chlorination batch tests.

Four batches will be tested with varying free chlorine doses (corrected for breakpoint destruction of any ammonia). Samples will periodically be collected from the batch to test free and total chlorine residual and THM concentrations. One intermediate and one final sample will also be measured for NDMA, *E. coli*, and total coliform.

The THM formation kinetics at various free chlorine doses will help determine a maximum allowable free chlorine dose and will assist in forming the design criteria for a sequential chlorination system.

Sequential chlorination batch tests

The second set of batch tests determines DBP formation and pathogen inactivation from sequential chlorination with various doses of free chlorine during the first phase and a consistent combined chlorine dose in the second phase. These batch tests are described in detail in Appendix B, Sequential Chlorination Batch Tests.

The sequential chlorination batch tests should use secondary effluent sample collected at the same time as the free chlorine batch tests. Ideally, the sequential chlorination tests will be conducted during the same day as the free chlorine tests, or, at the latest, the following day to reduce the possibility of biological degradation. The original temperature should be restored, and the biological tests should be repeated on each day the sample is used.

Two free chlorine doses (corrected for breakpoint destruction of ammonia) will be chosen from the free chlorination batch tests to achieve a free chlorine residual of less than 1 mg/L within the first 30 minutes of contact time. One batch test is run with each of these free chlorine doses. When the free chlorine residual drops below 1 mg/L, the preformed monochloramines are added. Use the method given in Appendix D, Additional Laboratory Instructions, to prepare the monochloramine solution. Samples will periodically be collected from the batch after monochloramine is added to test for total and monochloramine chlorine residual and THM concentrations. One intermediate and the final sample will also be measured for NDMA, *E. coli*, and total coliform.

The THM and NDMA formation in these tests will be used to balance free chlorine and combined chlorine contacts times in the sequential chlorination configuration.

Fullscale observation

Observation of the fullscale east plant over two months will provide valuable information about the system characteristics and consistency. The recommended data collection regimen is described in detail in Appendix C, Fullscale Observations.

Analysis of Results

All results should be returned to CH2M HILL for analysis. Discuss free chlorine batch test results with CH2M HILL before selecting doses for sequential chlorination batch tests.

Further studies may be recommended if insufficient inactivation or excess DBP formation is observed.

Appendix A

Free Chlorine Batch Tests

The proposed batch test determines DBP formation and pathogen inactivation during free chlorine disinfection of a single secondary effluent sample. The batch test will be repeated for four chlorine doses as indicated below. Characterization of the secondary effluent provides context for the interpretation of batch test results.

Batch #1 = 3 mg/L free chlorine

Batch #2 = 6 mg/L free chlorine

Batch #3 = 9 mg/L free chlorine

Batch #4 = 12 mg/L free chlorine

Tests

Unless otherwise noted, test methods should be consistent with those routinely used at Ina Road to allow direct comparison with plant operational data.

- pH
- Temperature
- TOC
- DOC
- UV-254 Absorption
- TSS
- COD
- Ammonia - *Detection limit ≤ 0.1 mg/L*
- Total coliform
- *E. coli*
- Free chlorine residual - *DPD or Indophenol method*
- Total chlorine residual - *DPD method*
- THM
- NDMA - *Use laboratory certified for NDMA, detection limit ≤ 10 ng/L. (E525-SIM)*

Sample Collection

Test or preserve each sample immediately after collection. Preservation method varies with test and should follow recommendations of Ina Road laboratory staff. If tests are performed at a commercial laboratory, that laboratory will supply instructions for proper preservation of samples.

Total Coliform and *E. coli* in the secondary effluent is expected to be approximately 10^4 - 10^5 MPN/100 mL. Samples should be diluted so as not to exceed testing range. Adjust results for dilution factor.

Samples removed from the batch during the test should be quenched with sodium thiosulfate unless testing for free or total chlorine residual. See Appendix D, Additional Laboratory Instructions for more discussion of quenching.

Procedure

1. Prepare a dilute stock solution of hypochlorite. Refer to Appendix D, Additional Laboratory Instructions, for a discussion of stock solution and glassware preparation.

2. Collect a secondary effluent sample from the BNRAS process, upstream of chlorination. Sample volume should be sufficient for characterization and all free and sequential chlorination batch tests.

3. Refer to Table 2 for characterization of secondary effluent. The pH, temperature, and UV-254 absorption tests should be started immediately. Run the ammonia, *E. coli*, and total coliform tests in triplicate.

4. Collect TSS, TOC, DOC, COD, and NDMA samples for immediate testing or preserve as appropriate and store at 4°C.

5. Transfer 3 L of secondary effluent to each batch test reactor. Store any sample not immediately used at 4°C with no preservatives. Prior to running additional batch tests, return sample to original temperature.

6. Refer to the ammonia concentration from step 3. If the concentration is greater than 0.3 mg/L ammonia-nitrogen, then additional hypochlorite solution will be required to reach breakpoint and eliminate the ammonia. Add 0.76 mg/L of additional chlorine (as Cl_2) for every 0.1 mg/L NH_3-N above 0.3 mg/L.

7. Stir batch at high speed to create a vortex. Slowly add the hypochlorite dose as indicated above for batches #1 through 4 plus any additional dose required by step 6. Start timer.

8. Refer to Table 2. At the times listed collect samples and run the specified tests. Perform all biological tests in triplicate.

Reporting Results

Perform the batch test once for each free chlorine dose and send all results to CH2M HILL for analysis. Discuss results with CH2M HILL prior to running sequential chlorination batch tests.

TABLE 2
Free Chlorine Batch Test
Disinfection Byproducts with Free and Sequential Chlorination

Test	Secondary Effluent (When collected)	Secondary Effluent (When reheated)[1]	Chlorine Contact time (min)					
			3	6	12	30	60	150
pH	1							
Temperature	1	1						
TSS	1							
UV 254	1							
TOC	1							
COD	1							
Ammonia	3							1
Free chlorine			1	1	1	1	1	1
Total chlorine	1		1	1	1	1	1	1
E. coli	3	3				3		3
Total coliform	3	3				3		3
THM	1		1	1	1	1	1	1
NDMA	1					1		1

[1] If reheated secondary effluent is used on the same day as original sample collection, then *E. coli* and total coliform tests do not need to be repeated on secondary effluent.

Appendix B

Sequential Chlorination Batch Tests

The proposed batch test determines DBP formation and pathogen inactivation during sequential chlorination disinfection of a single secondary effluent sample. The batch test will be repeated for two free chlorine doses as determined by the previous batch tests. Both batch tests will use the same combined chlorine dose.

Batch #5 = ___ mg/L free chlorine

Batch #6 = ___ mg/L free chlorine

Tests

Unless otherwise noted, test methods should be consistent with those routinely used at Ina Road to allow direct comparison with plant operational data.

- Temperature
- Ammonia – *Detection limit ≤ 0.1 mg/L*
- Total coliform
- *E. coli*
- Total chlorine – *DPD method*
- Free chlorine – *Indophenol method*
- Monochloramine – *Indophenol method*
- THM
- NDMA – *Use laboratory certified for NDMA, detection limit ≤ 10 ng/L. (E525-SIM)*

Sample Collection

Test or preserve each sample immediately after collection. Preservation method varies with test and should follow recommendations of Ina Road laboratory staff. If tests are performed at a commercial laboratory, that laboratory will supply instructions for proper preservation of samples.

Samples removed from the batch during the test should be quenched with sodium thiosulfate unless testing for free chlorine, total chlorine, or monochloramine residual. See Appendix D, Additional Laboratory Instructions for more discussion of quenching.

Procedure

1. Verify dilute hypochlorite stock solution concentration and condition all batch test glassware as described in Appendix D, Additional Laboratory Instructions.

2. Prepare a monochloramine stock solution at a 3.5 : 1 chlorine to ammonia-nitrogen weight ratio as described in Appendix D, Additional Laboratory Instructions.

3. Warm the stored secondary effluent sample to its original temperature.

4. If secondary effluent sample was not collected on the day of this batch test, measure *E. coli* and total coliform. Test ammonia in triplicate.

5. Transfer 3 L of secondary effluent to each batch test reactor.

6. Refer to the ammonia concentration from step 4. If the concentration is greater than 0.3 mg/L ammonia-nitrogen, then additional hypochlorite solution will be required to reach breakpoint and eliminate the ammonia. Add 0.76 mg/L of additional chlorine (as Cl_2) for every 0.1 mg/L NH_3-N above 0.3 mg/L.

7. Stir batch at high speed to create a vortex. Slowly add the hypochlorite dose as indicated in Table 3 plus any additional dose required by step 6. Start timer.

8. Measure free chlorine and THM concentration at 5 minute intervals until the free chlorine is at or less than 1.0 mg/L, as indicated in Table 3.

9. When free chlorine is observed at or less than 1.0 mg/L and at least 15 minutes have passed, immediately add 5.0 mg/L of preformed monochloramine and record the time as *T*. Whenever the sample has 0.5 mg/L of free chlorine residual, immediately add the preformed monochloramines. For example:

   a. if the free chlorine residual is 1.0 mg/L or less after 10 minutes, continue the test without adding monochloramine until 15 minutes, at which time add preformed monochloramine.

   b. if the free chlorine residual is 0.5 mg/L at 10 minutes, immediately add the preformed monochloramines.

   c. if the free chlorine residual is greater than 1.0 mg/L after 15 minutes, continue the test without adding monochloramine until the free chlorine residual is at or less than 1.0 mg/L.

10. Refer to Table 3 and run the specified tests at the times listed. Perform all biological tests in triplicate.

Reporting Results

Perform the batch test once for each free chlorine dose and send all results to CH2M HILL for analysis.

TABLE 3
Sequential Chlorination Batch Tests
Disinfection Byproducts with Free and Sequential Chlorination

Test	Secondary Effluent (Warmed to original temperature)	Chlorine Contact time (min)				
		Every 5 minutes until time *T* [1]	T+5	T+20	T+60	150
Temperature	1					
Ammonia	3					1
Total chlorine			1	1	1	1
Free chlorine		1	1			
Monochloramines			1	1	1	1

E. coli	3			3		3
Total coliform	3			3		3
THM		1	1	1	1	1
NDMA				1		1

[1] Time *T* is the time at which the free chlorine is observed less than or equal to 1.0 mg/L and at least 15 minutes have passed.

Appendix C

Fullscale Observations

Careful observation of the fullscale east plant over two months, when combined with historical data, will provide valuable information about the system characteristics and consistency. This data is necessary to determine total chemical capacity needed for the disinfection process.

Daily Observations

- *E. coli* - East Secondary Effluent, grab
- *E. coli* - East Chlorine Contact Basin Effluent, grab
- Ammonia - East Secondary Effluent, composite
- TKN - East Secondary Effluent, composite
- Chlorine feed rate - East Chlorine Contact Basin, hourly observation

Weekly Observations

- NDMA - East Chlorine Contact Basin Effluent, grab
- THM - East Chlorine Contact Basin Effluent, grab

SCADA Data

- Chlorine Residual - East Chlorine Contact Basin, continuous
- Turbidity - East Secondary Effluent, continuous
- BNRAS Flow - daily

Appendix D

Additional Laboratory Instructions

Treating Analysis Glassware

All glassware that will contact hypochlorite or monochloramine must first be conditioned to eliminate chlorine demand. Add 1 mL hypochlorite stock solution to each liter of DI water. Fill glassware and allow to soak for a few minutes. Rinse with DI water.

Secondary Effluent Storage

Secondary effluent for all batch tests will be collected at one time. Not all batch tests will be run immediately. Store secondary effluent at 4°C with no preservatives. Secondary effluent should be used within two days of collection. Heat secondary effluent to its original temperature before use.

Quenching Residual Disinfectant

When a chemical or biological sample is taken from a disinfection batch test, the reaction must be stopped by quenching residual disinfectant in the sample. Free and combined chlorine residual are quenched by sodium thiosulfate. Do not quench samples taken to measure the disinfectant residual.

Prepare a 1 g / 10 mL sodium thiosulfate solution. To quench a sample, add 10 uL of sodium thiosulfate solution per 10 mL of sample. Invert sample to mix.

Dilute Hypochlorite Stock Solution Preparation

Condition a 500 mL and a 1000 mL volumetric flask as described above.

Add 8.3 mL of 6% NaOCl stock to the 500 mL volumetric flask, dilute to volume with DI water, and mix well by inverting and swirling. This will be the "dilute hypochlorite stock solution" for use in the batch tests.

Add 1 mL of dilute hypochlorite stock solution to the 1000 mL volumetric flask, dilute to volume with DI water, and mix well by inverting and swirling. This will be Solution 2.

Measure the free chlorine in Solution 2 by pipetteing a 10 mL aliquot of sample into the free chlorine vial. Add a Free Chlorine DPD packet and gently shake for 30 seconds. Wipe the vial with a Kimwipe and measure with the chlorine meter. Multiply the result by the dilution factor of 1,000 to get the strength of the dilute NaOCl solution in mg/L. The result should be ~1,000 mg/L as CL_2.

Repeat the Solution 2 dilution and measurement steps and average the results. Measurement of the dilute hypochlorite stock solution concentration must be repeated each day of testing.

Monochloramine Stock Solution Preparation

1) First prepare a phosphate buffer solution. In a 1 liter volumetric flask, add 0.345g monobasic sodium phosphate and 0.355g dibasic sodium phosphate, dilute to the line with DI water and shake to dissolve.

2) Prepare a dilute 120 mg/L ammonia solution. Carefully measure out 30 mL ammonia standard (1 mg/mL as nitrogen) into a 250 mL volumetric flask and dilute to the line with the phosphate buffer solution.

3) Preparation of monochloramine solution:

   a) A chlorine to ammonia-nitrogen weight ratio of approximately 4:1 is typically recommended for testing to minimize potential dichloramine formation. For this test the ratio will be reduced to 3.5:1 because free chlorine is still present in the sample when the preformed monochloramine is added.

   b) Calculate the amount of dilute NaOCl stock solution to add (the following equation is based on 250 mL of a 120 mg/L ammonia solution as described above and a desired ratio of 3.5 Cl_2 : 1 NH_3-N):

$$Dilute\ NaOCl\ Stock,\ mL = \frac{(250mL\ solution) * (120mg/L\ Ammonia) * (3.5Cl_2 : 1NH_3 - N)}{measured\ dilute\ stock,\ mg/L}$$

   c) Stir the dilute ammonia solution at a speed high enough to create a vortex in the beaker and slowly, drop-wise, add the calculated amount of dilute NaOCl stock to the ammonia solution.

   d) Pour the monochloramine solution into an amber glass bottle for storage.

   e) Measure the monochloramine, free chlorine, and total chlorine concentrations:

   f) Monochloramine Measurement with Indophenol method: Pipette a 10 mL aliquot of sample into the monochloramine vial. Add a Monochlor-F packet and gently shake the vial for 30 seconds. Allow color to develop for three minutes. Wipe the vial with a Kimwipe and measure with the monochloramine meter. Then zero the monochloramine meter using the monochloramine vial for the free chlorine measurement.

   g) Free Chlorine Measurement with Indophenol method: Pipette a 10 mL aliquot of sample into the free chlorine vial. Add five drops of indophenol solution and gently shake the vial before adding a Monochlor-F packet and gently shaking for 30 seconds. Allow color to develop for three minutes. Wipe the vial with a Kimwipe and measure with the meter zeroed on the monochloramine vial.

   h) Total Chlorine Measurement with DPD method: Pipette a 10 mL aliquot of sample into the total chlorine vial. Add a total chlorine reagent pillow pack and gently shake the vial for 20 seconds. Wait 3 minutes for complete reaction with total chlorine. Wipe the vial with a Kimwipe and measure with the chlorine meter.

   i) A measure of success in creating a strong monochloramine solution is to divide the monochloramine concentration by the total chlorine concentration. The solution should be > 95% monochloramine. If the solution is less than 95% monochloramine, repeat preparation of stock solution.

APPENDIX "B" REVISION 12/7/09

I. COMPENSATION SCHEDULE – COST PLUS FIXED FEE, NOT TO EXCEED

TASK			Budget
Phase 1 - Preliminary Engineering Services			**$5,533,836.00**
Task 1 Project Management		$562,575.00	
Task 2 Permitting Assistance		$139,197.00	
Task 3 Interim Biosolids		$1,753,168.00	
Preliminary Design, Field & Pilot Test, Schematic Design	$628,562.00		
Design Development, Contract Documents, Final Documents	$1,124,606.00		
Task 4 Preliminary Design		$843,578.00	
Task 5 Field Investigation		$84,512.00	
Task 6 Schematic Design		$1,413,039.00	
Other Direct Costs		$427,767.00	
Subconsultants		$310,000.00	
Phase 2 - Final Design Services			**$7,500,513.00**
Task 1 Project Management		$708,603.00	
Task 2 Permitting Assistance		$417,590.00	
Task 7 Design Development		$2,299,650.00	
Task 8 Contract Documents		$2,638,792.00	
Task 9 Final Documents		$987,004.00	
Other Direct Costs		$448,874.00	
SubConsultants		$0.00	
Phase 3 - Construction Phase Services (Allowance)			**$3,395,573.00**
Amendment # 5			**$537,199.00**
CO # 6 – Additional Headworks Replacement and Odor Control DES		$216,200.00	
CO # 9 – New Switchgear Building DES		$300,099.00	
WET Testing and Disinfection By Product Formation Bench Testing		$20,900.00	
DP Fixed Fee (Phases 1 & 2)			**$1,540,111.00**
Monthly Fixed Fee			
Phase 1 Preliminary Engineering Services – Monthly Fixed Fee Allocation		$34,575.00	
Phase 2 Final Design Services – Monthly fixed Fee Allocation		$50,929.00	

Deliverable Fixed Fee			
Phase 1			
1.9	30% Cost Estimate - Interim Biosolids	$4,620	
1.9	60% Cost Estimate - Interim Biosolids	$7,520	
1.9	95% Cost Estimate - Interim Biosolids	$8,630	
1.9	100% Cost Estimate - Interim Biosolids	$3,228	
1.9	10% Cost Estimate	$1,050.00	
2	Permit Applications Complete and Submitted to Agency - Biosolids	$6,031	
3.4	30% Schematic Design Report - Biosolids	$27,238	
3.5	60% Design Development Documents - Biosolids	$18,913	
3.6	95% Construction Documents - Biosolids	$21,702	
3.7	100% Contract Documents - Biosolids	$8,117	
4.7	Final Preliminary Design Report	$36,555	
5	Field Investigations Complete	$3,662	
6.13	Final Schematic Design Report	$61,232	
Phase 2			
1.9	60% Cost Estimate	$11,916	
1.9	95% Cost Estimate	$13,674	
1.9	100% Cost Estimate	$5,115	
2	Permit Applications Complete and Submitted to Agency	$18,095	
7	Design Development Documents	$99,650	
8	Contract Documents	$114,345	
9	Final Contract Documents	$42,770	
Amendment #5 DP Fixed Fee			**$62,300.00**
	CO # 6 – Additional Headworks Replacement and Odor Control	$27,800	
	CO # 9 – New Switchgear Building	$34,500	
Total Compensation (Not to Exceed)			**$18,569,532.00**
Owners Contingency			**$29,967.00**
Total Contract Amount			**$18,599,499.00**

APPENDIX "B", CONTINUED

II. COMPENSATION

A. Task Budgets

The Compensation Schedule shall contain the negotiated cost allocations for each individual task. The compensation schedule shall be used to monitor cost expenditures. Once each individual task budget is agreed to it may not be changed except as noted in paragraph II.B below.

B. Cost Adjustments

The compensation schedule presented above is an estimate of the level of effort required to complete each task within each Phase. It is acknowledged that as such, the actual level of effort for each task within each Phase may change. If, for valid reason(s), the DP notifies the PM/CI and Owner that the compensation schedule needs to be adjusted Owner, will consider modifying task cost allocations as may be requested by the DP. After Owner approval the PM/CI and the Owner will work with the DP to process and approve adjustments in a reasonable time and in a reasonable manner. No adjustment of costs between tasks may be made without Owner's written authorization. The total not to exceed compensation for this Contract may be increased only by formal amendment to this Contract.

It is understood, however, that the actual work scope of Phase 2 - Final Design is dependent upon the work effort results of Phase 1 - Preliminary Design and thus the actual cost for Phase 2 can not be completely defined until the Project to be actually designed is agreed to by the OWNER as a result of the DP's Phase 1 work effort.

For the purposes of estimating the cost of Phase 2 and based upon the Preliminary Engineering Information contained in Attachment A to the OWNER's Solicitation for Qualifications Number #0801125, the DP has estimated that it will take 1212 construction contract drawings to adequately describe the Project for CMAR construction. Should the scope of the Project, as a result of Phase 1 Preliminary Design work effort, result in a design work effort requiring more than 1235 or less than 1185 drawings being required to describe the Project for the CMAR to construct, the OWNER and DP agree to negotiate in good faith an equitable adjustment to the cost and fee for Phase 2. Any adjustment to the cost and fee shall be agreed to by Owner and DP prior to DP commencing any work under Phase 2 – Final Design.

C. Fixed Fee

The monthly allocation of the fixed fee, as shown in the compensation schedule, shall be paid each month contingent upon the DP having provided all scheduled deliverables due prior to the invoice date identified in the Scope of Work or Baseline Project Schedule. If the Scope of Work and Baseline Project Schedule do not have any deliverables for the month in which the costs are incurred and all previous months deliverables have been delivered, the DP will invoice for the fixed fee and be paid the fixed fee in accordance to the Compensation Schedule in Section I of this appendix.

The deliverables portion of the fixed fee, as shown in the compensation schedule, shall be paid upon successful completion of each task deliverable listed.

III. INVOICING

A. Invoice Transmittal

Invoices shall be submitted monthly, prior to the Monthly Progress Meeting, to the PM/CI, with appropriate supporting data and documentation and in a format as prescribed by the Owner. (Acceptance of the invoice at this meeting is not mandatory. The PM/CI may delay approval for up to 5 work days to review the Progress Report and invoice.) The invoice shall tabulate the costs associated with each individual task. Any invoice which lists a requested payment for any individual task beyond the current approved task budget will be rejected. All Task (deliverables) and Subcontracted Service costs shall be appropriately documented. The PM/CI shall review and check the invoice to determine if it is complete and acceptable; if it is determined to be complete and acceptable, the PM/CI will approve the invoice and forward it to Owner for processing and payment.

B. Fee Schedule

Invoicing fees will be in accordance with the Compensation Schedule and Fee schedule in Section I of this appendix. Any changes in the compensation schedule or fee schedule will have prior written approval of Owner.

C. Invoice Summary

Due to this Contract including work under several separate Owner projects, DP shall include a summary page which shows amount expended each month for each project. The summary page shall be in the format similar to the one shown below and include the listed projects.

Project Summary

Project	Project #	Contract Budget	Amount this Invoice	Amount to date
Total Contract		**$17,970,033**		
Phase 1 and 2		**$14,564,639**		
HPO Replacement	3RIR03	$4,384,737		
12.5 Expansion	3RIR04	$3,173,587		
BNRAS Modifications	3RIR05	$1,897,765		
Biosolids	3RIR06	$3,058,550		
Interim Biosolids	3RIR06	$2,000,000		
Digester Mechanical Thickening/Dewatering	3IRG11	$50,000		
Phase 3		**$3,405,394**		
HPO Replacement	3RIR03	$1,181,671		
12.5 Expansion	3RIR04	$855,094		
BNRAS Modifications	3RIR05	$511,490		
Biosolids	3RIR06	$647,139		
Interim Biosolids	3RIR06	$200,000		
Digester Mechanical Thickening/Dewatering	3IRG11	$10,000		