

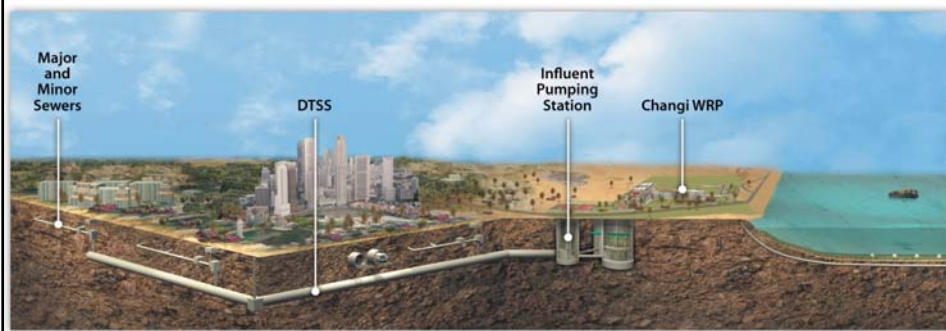
Achieving Construction Excellence in Singapore: The Changi Water Reclamation Plant

2010 CM Seoul Forum and Global CM Contest
Presenter: Bill Van Wagenen, CH2M HILL
April 29, 2010

Agenda

- ◉ Project Purpose and Vision
- ◉ Project Scope
- ◉ CM Scope
- ◉ Major Construction Challenges
- ◉ Key CM Approaches
- ◉ Project Results

The Singapore Public Utilities Board (PUB) undertook one of the world's largest wastewater collection and treatment projects.



PUB Project Goals

- Consolidate all WWTP needs into one plant
 - Free up land from seven existing WWTPs
 - Clean up Straits of Malacca
 - Produce treated effluent that can be treated to drinking water standards
- Minimize plant footprint and land requirements



Singapore map source: www.pub.gov.sg

Project Scope

The Changi WRP is the heart of the PUB's wastewater system.

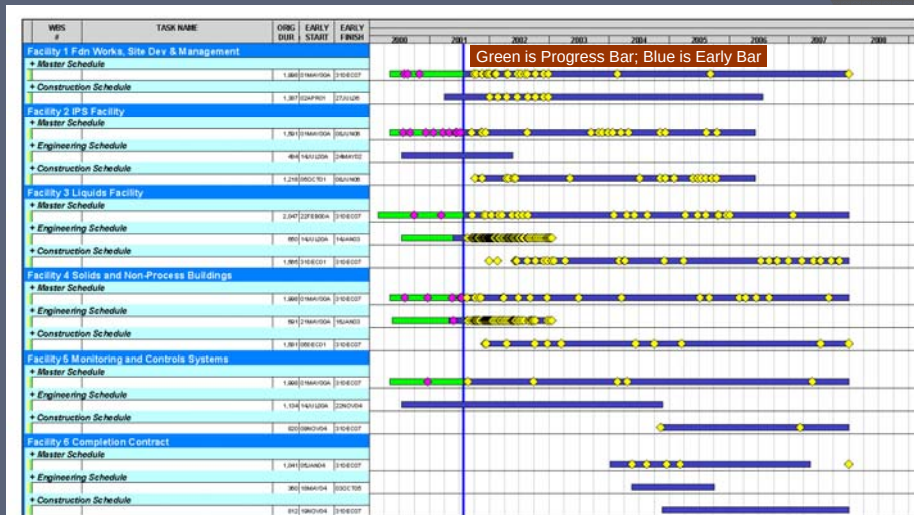
- ⦿ 800,000 m³/day capacity
- ⦿ Plant goals:
 - Small footprint
 - Odor control
 - Aesthetic appearance
 - Multi-modal use
- ⦿ Clarifiers are buried; other facilities are aboveground
- ⦿ NEWater factory on rooftop



Some Project Parameters

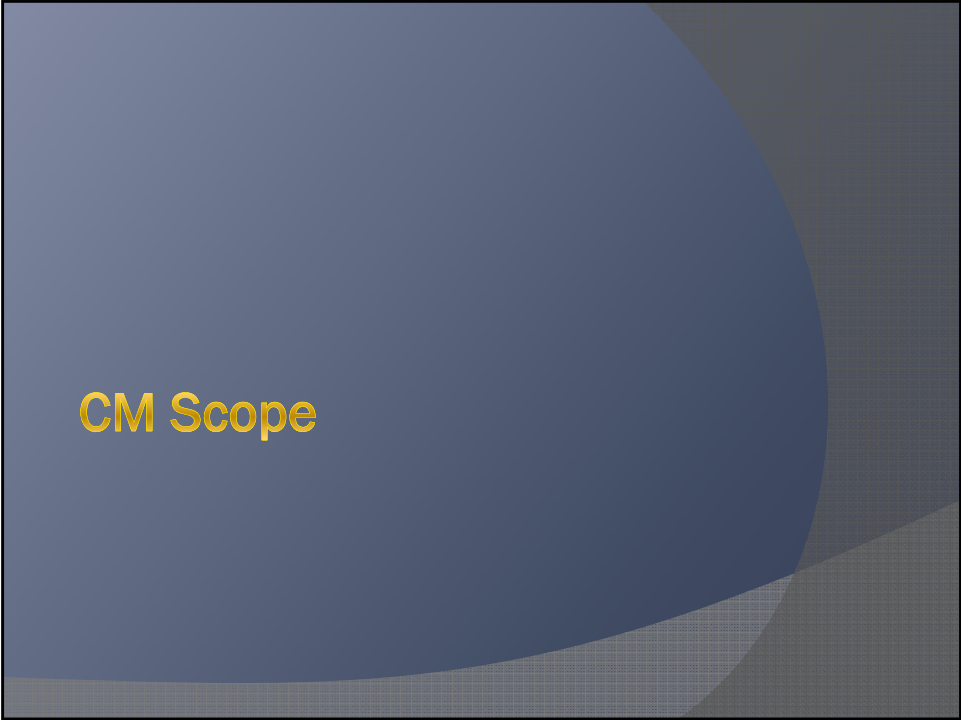
- 4.5 million m³ excavated
- 3,300 bored piles
- 1.6 million m³ of concrete
- 1.7 km of influent and bypass pipelines
- Pump station has ten 73,000 gpm pumps

Construction Baseline

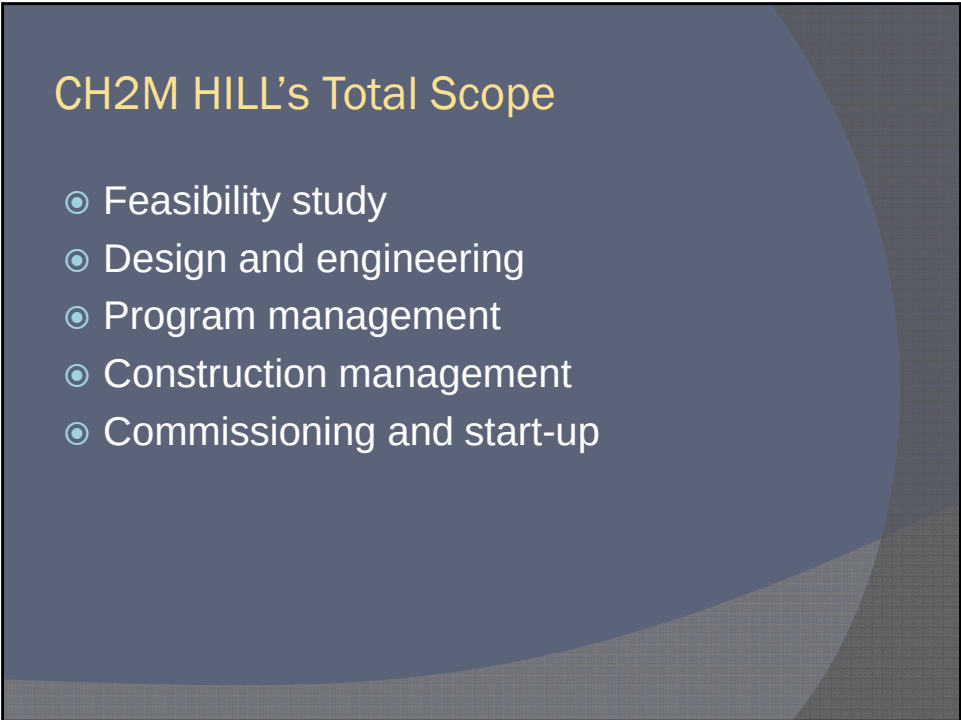


Budget estimate = USD 1.3 billion

Baseline construction schedule = 84 months (April 2001 - March 2008)



CM Scope



CH2M HILL's Total Scope

- ◉ Feasibility study
- ◉ Design and engineering
- ◉ Program management
- ◉ Construction management
- ◉ Commissioning and start-up

CH2M HILL's CM Scope

- Planning
- Management
- Supervision of all construction and site management
- Coordination for all government approvals
- Quality assurance, including inspection of all works
- Safety and environmental management
- Commissioning
- Total CM fees were <2% of construction

At the peak of construction, 147 CM staff managed contractors employing more than 4,500 construction workers.

Role	Site Management Team	Contract Group							Total
		1	2	3	4	5	6	7	
Overall Construction Manager	1								1
Deputy & Contract Group Construction Managers		1	1	1	1	1	1	1	7
Contract Group QS		1	1	1	1	1	1	1	7
Contract Group Contracts Engineers		1	1	1	1	1	1	1	7
Project Controls Manager	1								1
Project Controls	5								5
Procurement Clerks								1	1
Material Controller/Coordinator	1								1
QA, Safety, Risk & Training Manager	1								1
Chief Resident Engineer	1								1
Lead Resident Engineers	5								5
Contract Group Resident Engineers	1	1	3	3	4	4	1		17
Junior Engineer	4								4
CADD Technicians	5								5
Chief Inspector	1								1
Contract Group Lead Inspectors		1	1	1	1	1	1	1	7
Inspectors		11	19	29	34	6	6		105
Administrative Assistant & Clerks	6								6

Major Construction Challenges

The Changi WRP had many construction challenges.

- ◉ Greenfield site with WWII UXO
- ◉ Constrained site with limited access
- ◉ Permeable sand fill saturated with seawater
- ◉ Seabed with pockets of soft, unstable marine clay
- ◉ Separate equipment procurement contracts needed to be coordinated with construction of facilities

Construction occurred on a highly constrained site.



Plant site in January 2002

Innovative construction methods were required for the Influent Pump Station.

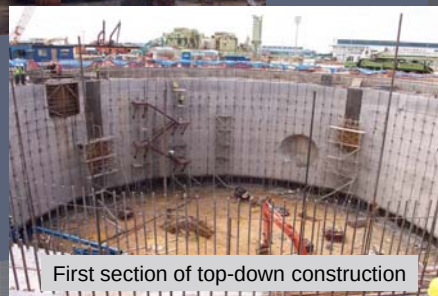


IPS shaft construction



Bill and Ed escaping the office

Placing concrete on first top-down section



First section of top-down construction

Major equipment was installed.

Setting first of ten 72,975-gpm pumps in the IPS



High-speed centrifuges

The project involved substantial large vertical construction.

Roadway access bridge to top of liquids structure



Solids Building



Digesters

Key CM Approaches

CH2M HILL teamed with a major Singapore CM firm to combine international expertise with local knowledge.



We left behind a legacy of trained personnel for future projects.

- ⦿ Aggressive local recruiting and training
- ⦿ Transitioned CM team from 80% expatriate staff to only 3 at the end of the project

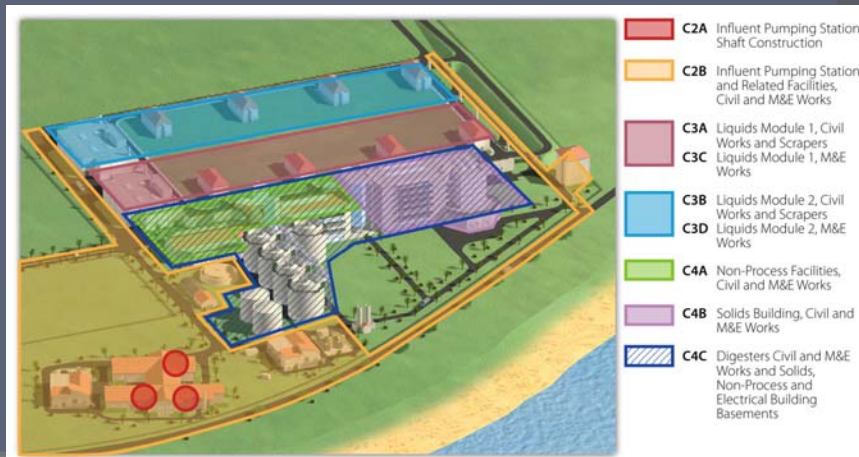


The CM Plan replaced “watch and report” with proactive CM procedures.

- ⦿ Registered and approved under ISO 9001 and thus subject to regular auditing
- ⦿ Actively managed construction to meet PUB’s expectation for on-time, on-budget delivery
 - E.g., overcoming routine breakdowns of bored piling machines



The Changi WRP was divided into seven contract groups; 20 construction contracts were issued.



Team chartering meetings at the beginning of each construction contract provided clear direction.

- Define project goals and standards
- Communicate program-wide processes, roles, and responsibilities
- Establish that contractors generally communicated with PUB team through CM staff
- Discuss transfer of technical knowledge and methods for continuous improvement

Clear lines of communication helped successfully resolve issues throughout the project.

- ◉ Daily communication between contractor PM and CM, resident engineers, and QA inspectors
- ◉ Weekly contract team meetings to discuss project status and potential issues
- ◉ Supplemental coordination meetings as needed for specific construction activities
- ◉ Monthly meetings of owner's PM, CH2M HILL's PM and CM, and contractors' staff
- ◉ Quarterly Executive Team meetings

The site management plan included an onsite 5,000 worker man-camp and sitewide management contractor.



3D models developed during design were used to better visualize and plan the construction.

Success begins with
a quality design

PUB & Contractor
Success



2D
DRAWING

- Material takeoffs
- Specifications
- Data Sheets
- Instrument Lists
- Equipment Lists
- and more

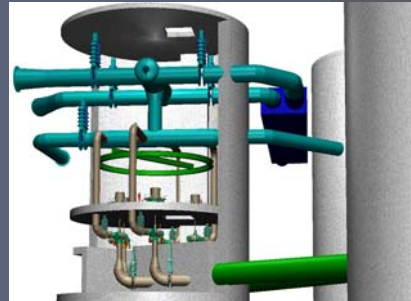
DATABASES



IMAGES



MODEL



3D model view from the
Changi WRP Influent Pump
Station preliminary design

Project Results

The project was completed successfully.

- Construction costs were USD1.2 billion—\$100 million under budget
- Completed construction schedule in 87 months—4 months later than planned due to weather delays
- No claims
- Award-winning project
 - CMAA 2009 Project Achievement Award
 - Global Water Awards 2009 Water Project of the Year
 - International Water Association 2008 Project Innovation Award



Questions

