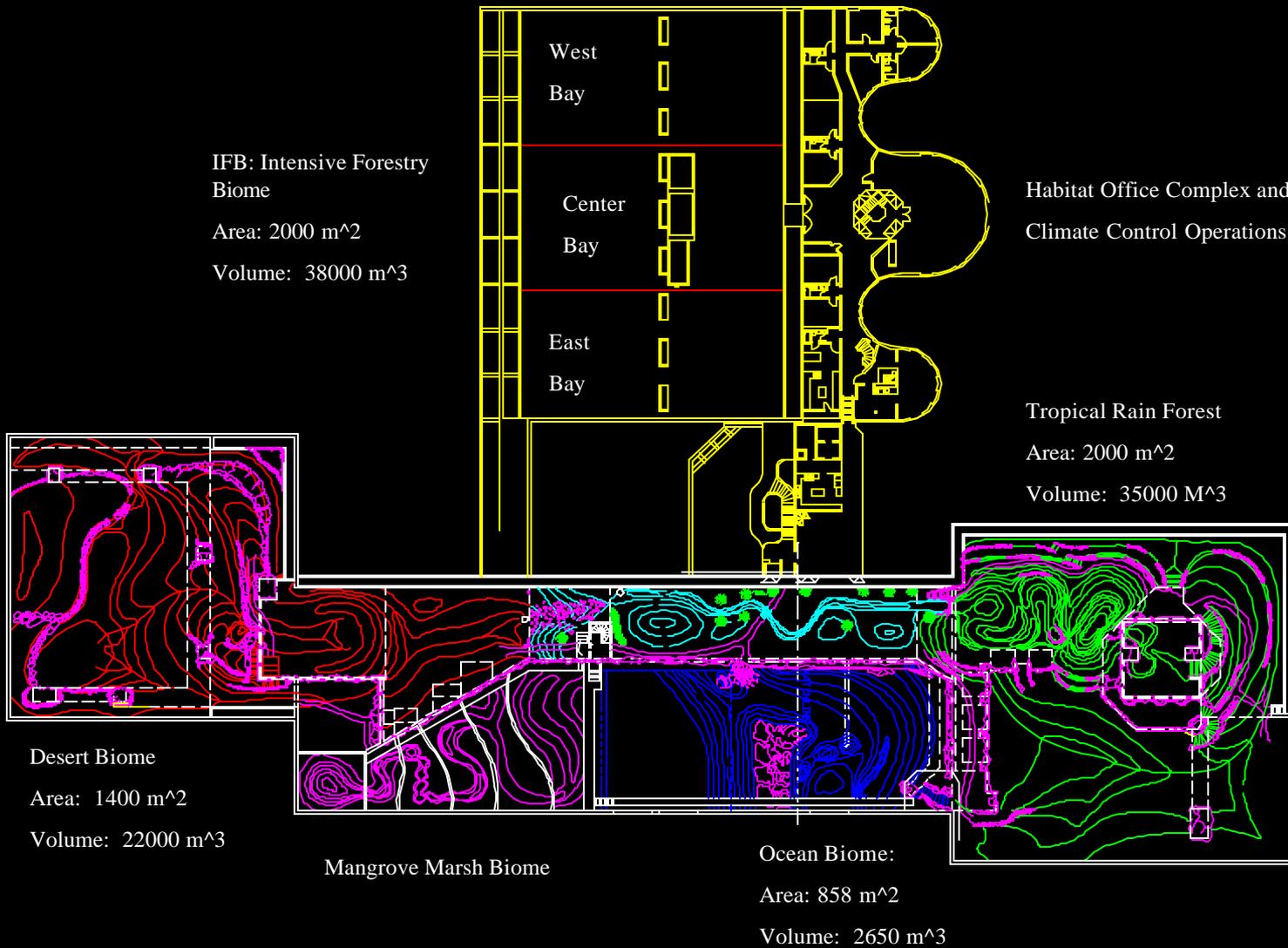


COLUMBIA UNIVERSITY'S

**BI**  **SPHERE 2** **CENTER**

Transition from “Closed” Manned Mission to “Controlled Environment” Research Program





Biosphere 2 Laboratory: Ground Floor Plan

Supports living biome areas.

“Technosphere” mechanical support below

## Biosphere 2 Laboratory “Technosphere”

Providing mechanical support to living biome areas above including:

Climate Control through air handlers (26) moving approx 1350 m<sup>3</sup> / min. each.

Water circulation.

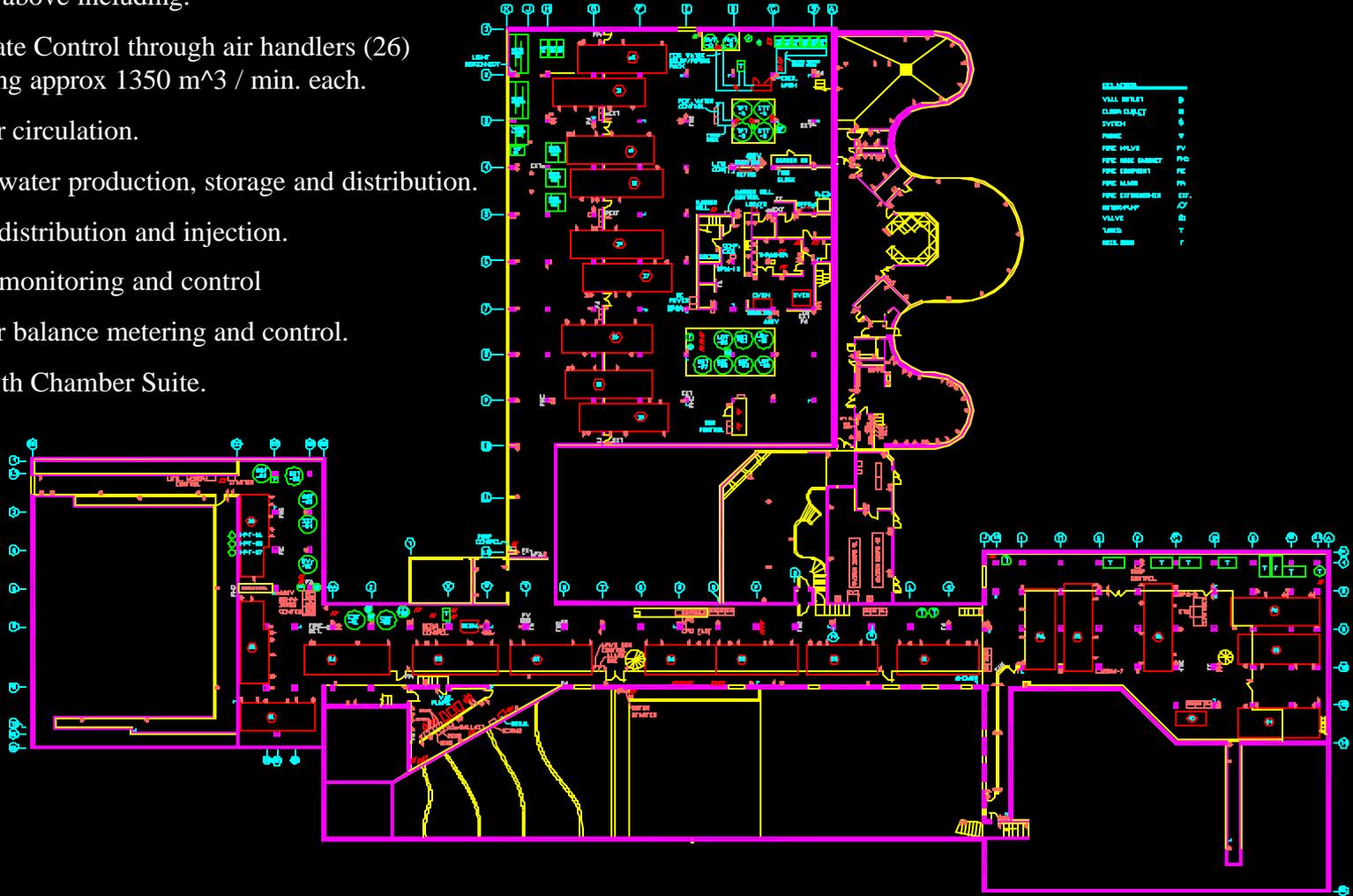
Rain water production, storage and distribution.

CO<sub>2</sub> distribution and injection.

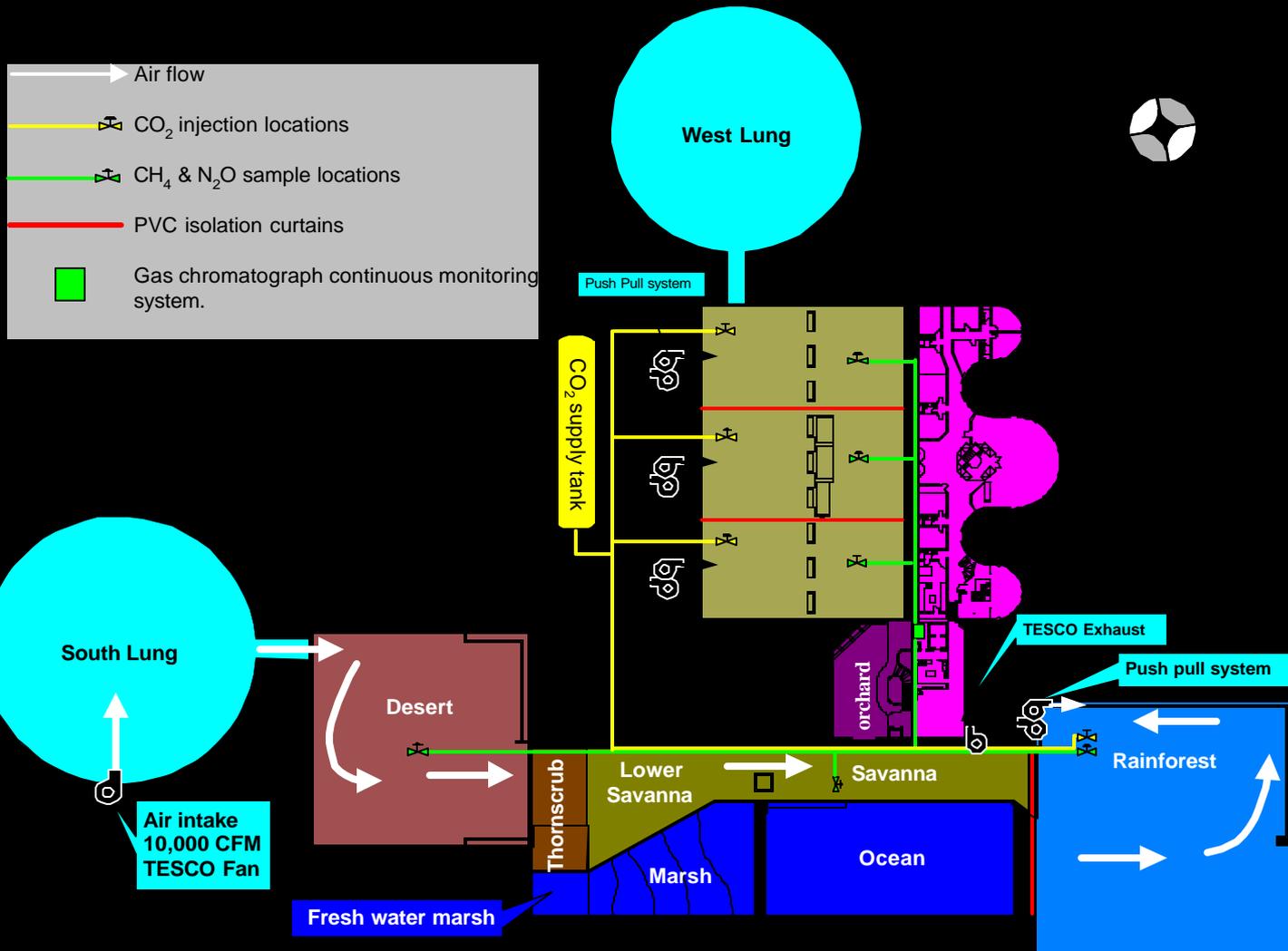
CO<sub>2</sub> monitoring and control

Water balance metering and control.

Growth Chamber Suite.



# Control Capabilities



## Tropical Rainforest PVC Separation Curtain



Biomes were first separated one from another with PVC curtains in order to investigate and understand the physical dynamics and physiology of the individual biomes.

Curtain systems extend through the “Technosphere” and effectively isolate the atmospheres of the biomes from each other.



IFB (Intensive Forestry Biome) chamber separation through use of PVC Curtain material. The IFB was initially one large chamber. The three vaulted roof structure lent itself to a logical separation into three separate chambers. The curtains extend through the “Technosphere” where the bays are separated by wood stud/PVC sheet walls. The chambers have a leak rate of 4 ½ - 5% / hour.

Each chamber is served by 3 air handlers for climate control.

Each chamber has separate CO2 control, water budget system and climate control.



CO2 Research focuses on Carbon Balance through CO2 control.

CO2 is injected during day to support CO2 levels during periods of photosynthesis .

CO2 is suppressed at night by dilution with outside air. All volumes are measured, recorded and analyzed for CO2 concentration, temperature and humidity to enable CO2 budget calculations.

CO2 injection control is accomplished with Licor Gas Hound IRGA and Sierra Mass Flow Controllers.

CO2 analysis uses Licor 6262 IRGA calibrated daily with analyzed span gasses.

Panametrics GM868 Ultrasonic Gas Flowmeters are used to measure volumes of exchange air used for suppressing CO2 rise during night respiration periods.





Water for rain, irrigation and misting fog is generated with an RO unit and is stored in tank farms in the “Technosphere” for later use.

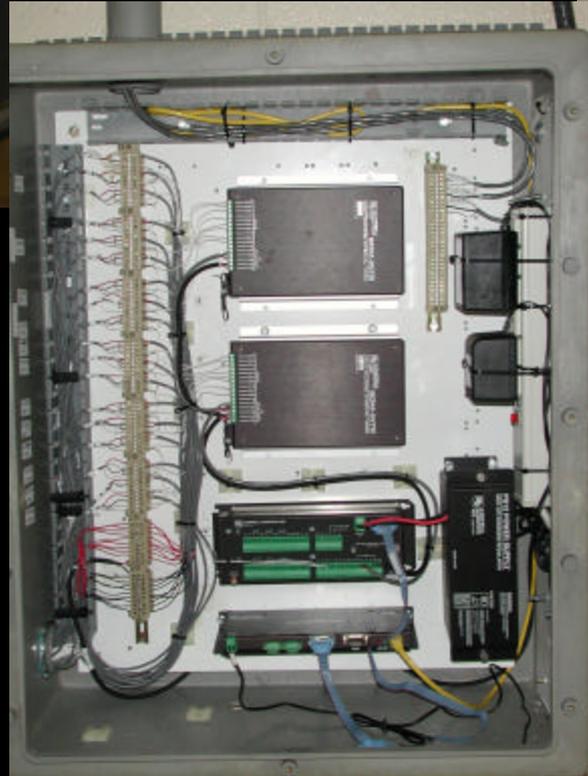


Data from water flow meters is collected on Campbell Scientific hardware and is acquired by a server running CSI's "Loggernet" software. Researchers anywhere have access to "real time" research data from the server with the use of this software.



Sub soil drainage water is collected from each bay, measured and reported to the data acquisition system and is then heat treated prior to it's export for use as irrigation water on the B2 site.

Condensate is collected from each Air Handler, measured with a flow meter, reported to a data acquisition system and is then exported to the Energy Center where it is used as make up water in the cooling towers.



**IFB Cottonwood Forest  
Center Bay**



## IFB Cottonwood Forest:

The cottonwood trees in these 3 bays are genetic clones of each other. NEE calculations are carried out throughout the growing season and are correlated to leaf level measurements carried out by technicians. Each growing season is concluded by copicing the trees, with new growth beginning each spring.

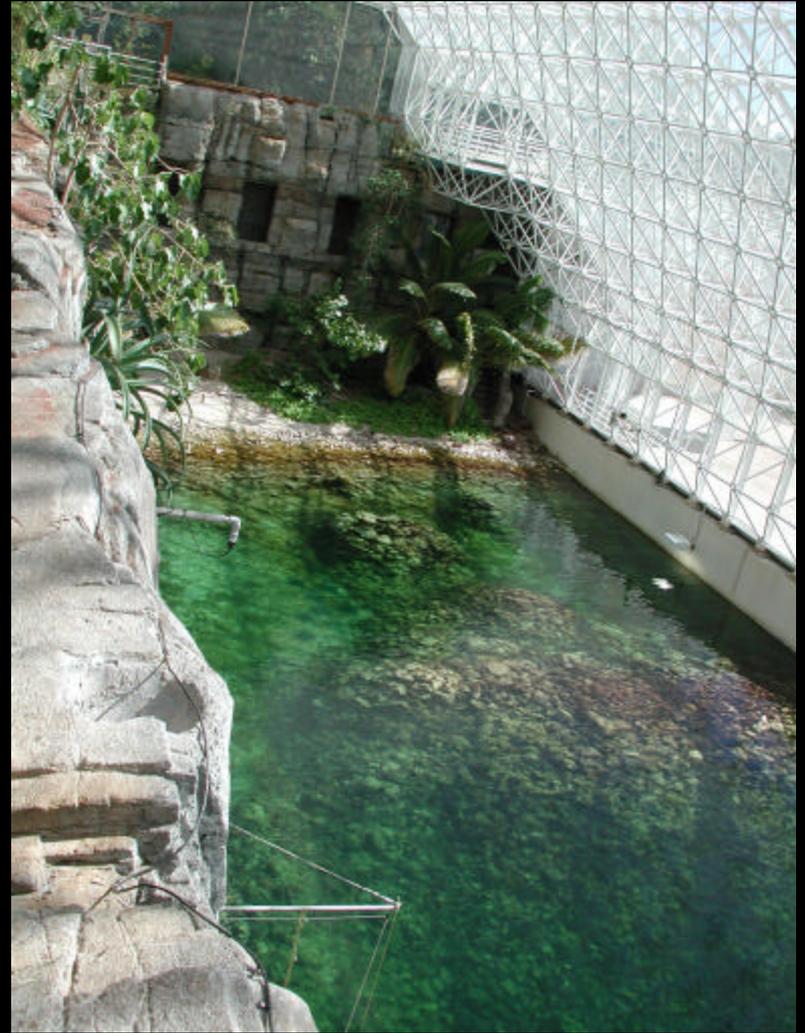
The current experimental protocol calls for each bay to be held at a different CO<sub>2</sub> level, the East Bay at 400, the Center Bay at 800 and the West Bay at 1200 micromoles/mole.

The chambers are instrumented both above and below ground with measurements taken for air temperature, air VPD, light levels throughout the canopy, soil temperature, soil moisture, CO<sub>2</sub> levels, and sample systems for Trace Gas Analysis.





Tropical Rain Forest beneath the Canopy.



Marine biome: 2,650,000 l salt water system, self sustaining.



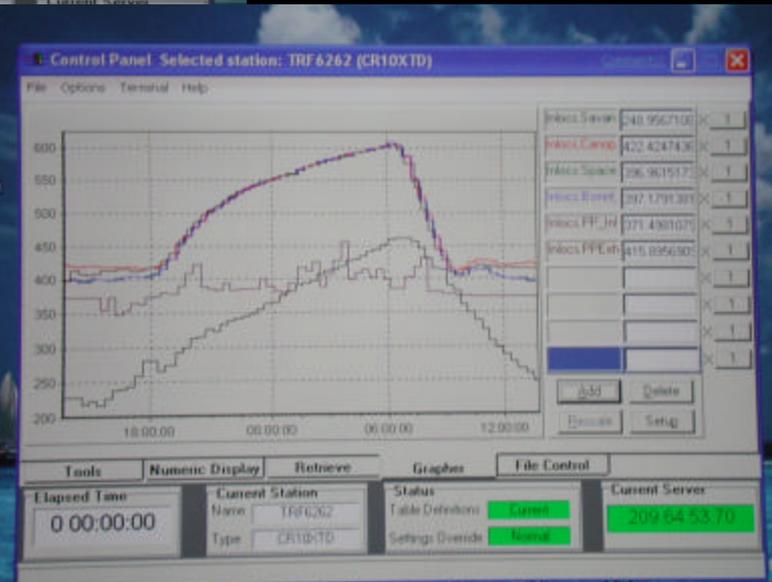
The Biosphere 2 Laboratory uses 2 separate SCADA (supervisory control and data acquisition) networks in its operation. One network is restricted solely to climate control and is strictly maintained so as to avoid any unauthorized access. The computer consoles shown above are part of that network. This is the control room where climate setpoints are defined, parameters monitored, personnel access to the Biosphere is logged, alarms answered and system status monitored. Radio pagers alert operators to alarms after hours.

The second SCADA network handles only research data from sensors and instruments in the field. This network is much more tolerant of access so as to provide maximum access and use of data for off site researchers. Research data is logged on Campbell Scientific Loggernet software and “real time” and archive data are available through the Loggernet software. Technicians and programmers on site make additions and alterations to this system on demand.



Loggernet software allows researchers to retrieve data in a variety of formats. "Real Time" data may be viewed as either trend charts or tables as shown here. Time scales and ranges are adjustable and alarm limits can be set for table fields.

Archive data can be retrieved in a number of formats and are selectable in a very flexible array of options.



Columbia University

Biosphere 2 Center

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[www.bio2.edu](http://www.bio2.edu)

