



technical report I

Denver Police Department Crime Lab || Denver, Colorado

lighting || electrical

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Table of Contents

Executive Summary	1
Building Overview	2
Circulation Lobby/Atrium	3
Spatial Description	
Existing Lighting Conditions	
Design Criteria	
Evaluation	
Special Purpose Space Multipurpose Room	7
Spatial Description	
Existing Lighting Conditions	
Design Criteria	
Evaluation	
Large Work Space Main DNA Lab	11
Spatial Description	
Existing Lighting Conditions	
Design Criteria	
Evaluation	
Outdoor Space South Plaza	15
Spatial Description	
Existing Lighting Conditions	
Design Criteria	
Evaluation	

Executive Summary

Existing conditions and design criteria outline what can and cannot be done to the lighting design within the Denver Police Department Crime Lab. In this report, these aspects are analyzed using the Illuminating Engineering Society Lighting Handbook, 10th Edition as well as the International Energy Conservation Code 2012 as text references.

The report is focused on the existing conditions of the following four spaces:

- Circulation Space || Lobby/Atrium
- Special Purpose Space || Multipurpose Room
- Large Work Space || Main DNA Lab
- Outdoor Space || South Plaza

Three schematic design concepts will be applied to the lobby/atrium. This space is a large circulation area, with visibility from all three floors. A psychological impression will be performed on the south plaza, where the Flynn Mode of relaxation shall be utilized.

Images in this document are courtesy of SmithGroupJJR and SSG.

Building Overview

All 60,000 SF of the Denver Police Department Crime Lab serve the public of Colorado through proper and thorough forensic investigation. Neighboring the lab in downtown Denver is the Police Department and Department of Safety, along with several other government buildings. The lab itself houses many facilities such as conference rooms, a multipurpose room, open offices, and various laboratories that allow their users to be able to work efficiently and effectively. Architecturally, the crime lab showcases a unique façade that was modeled after a double helix, or DNA molecule. This contemporary look continues on the interior of the building, where distinctive ceiling systems and modern labs.

Below are the First and Second Floor Plans labeled with the four spaces that will be redesigned:

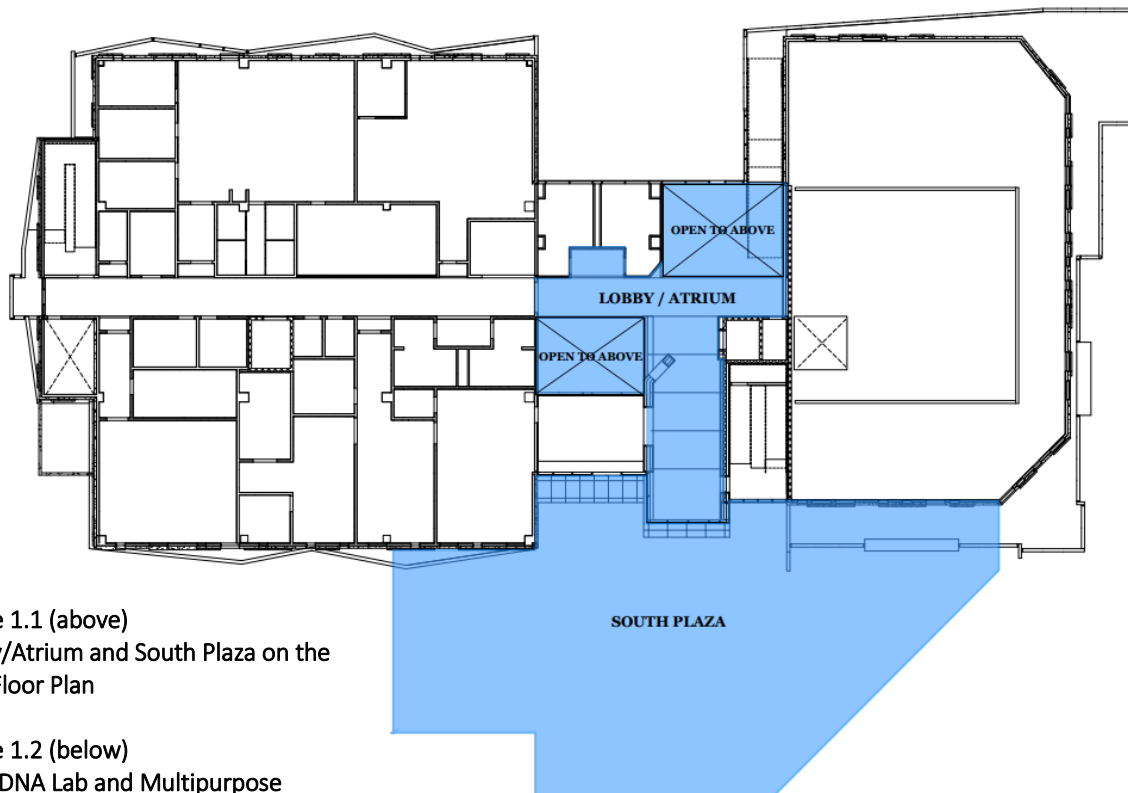
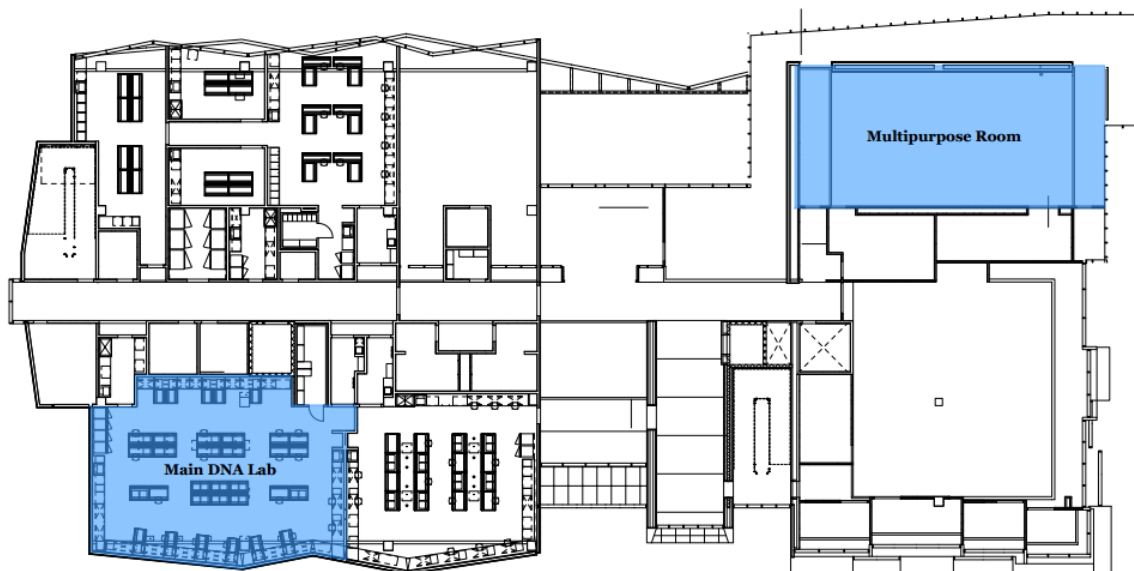


Figure 1.1 (above)
Lobby/Atrium and South Plaza on the
First Floor Plan

Figure 1.2 (below)
Main DNA Lab and Multipurpose
Room on the Second Floor Plan



Spatial Description

The lobby and atrium is the first space that you are greeted with when entering the building from the South Plaza. Located in the center the building, the most traffic occurs here. An elevator and exposed staircase both lend to the movement of the employees. There are two rectangular atriums (North Atrium and South Atrium) that are open to the second and third floor.



Figure 1.1 View of Stairs from Lobby

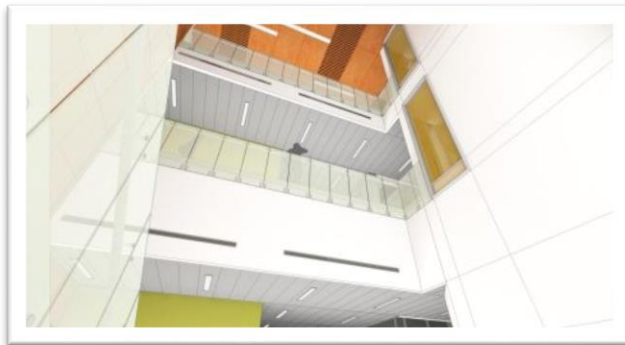


Figure 1.2 View of Floors 2 and 3 from Floor 1

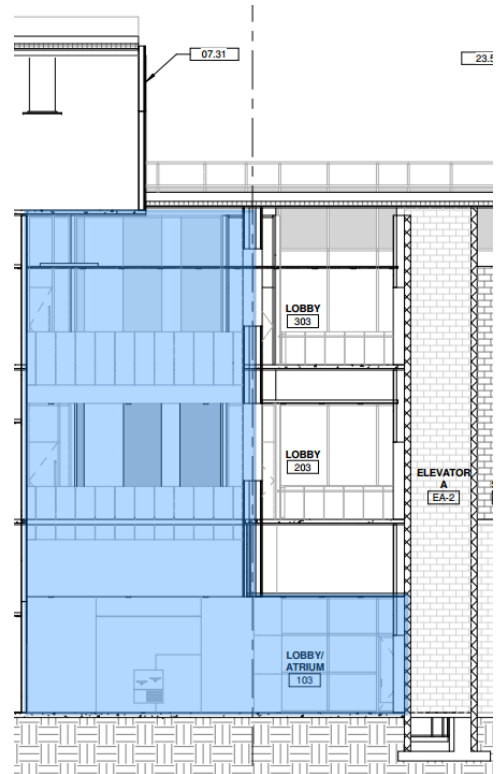


Figure 1.3 Longitudinal Section of South Atrium

Tasks || Activities

Transition
Reception
Lounge

Dimensions

Area: 1985 SF
Ceiling Height: 12'-0," 46'-0"
Room Length: 71'-0"
Room Width: 51'-0"

Materials

Ceiling: Perforated Metal Panels, Wood Laminate, Acoustical Wood Slots
Walls: Gypsum, Composite Panels
Floor: Terrazzo

Furnishings

Chairs
Couches
Tables

Existing Lighting Conditions

The Lobby/Atrium is where the largest number of diverse fixtures are present within the Crime Lab. The lamp sources are a combination of LED, linear fluorescent, and compact fluorescent.

The controls for this space are regulated by the reception in the South Atrium, where a low voltage switch is located behind the security desk. The vertically mounted Lumenbeam luminaires are separately controlled through Lumentouch.

The lighting plans below indicate the fixtures located in the Lobby/Atrium. On the next page is a fixture schedule to reference the plans with.

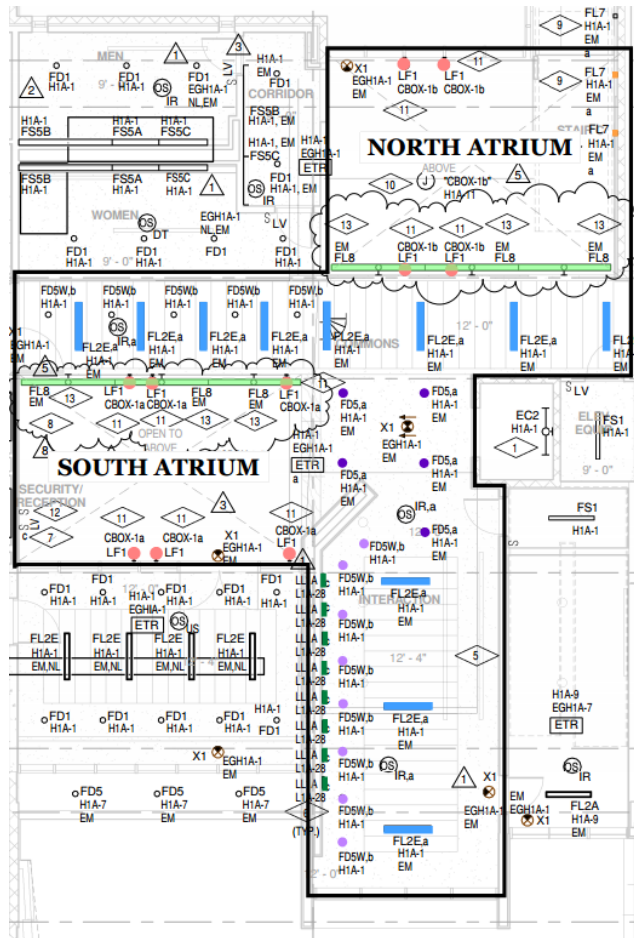


Figure 1.4.a | First Floor Lighting Plan

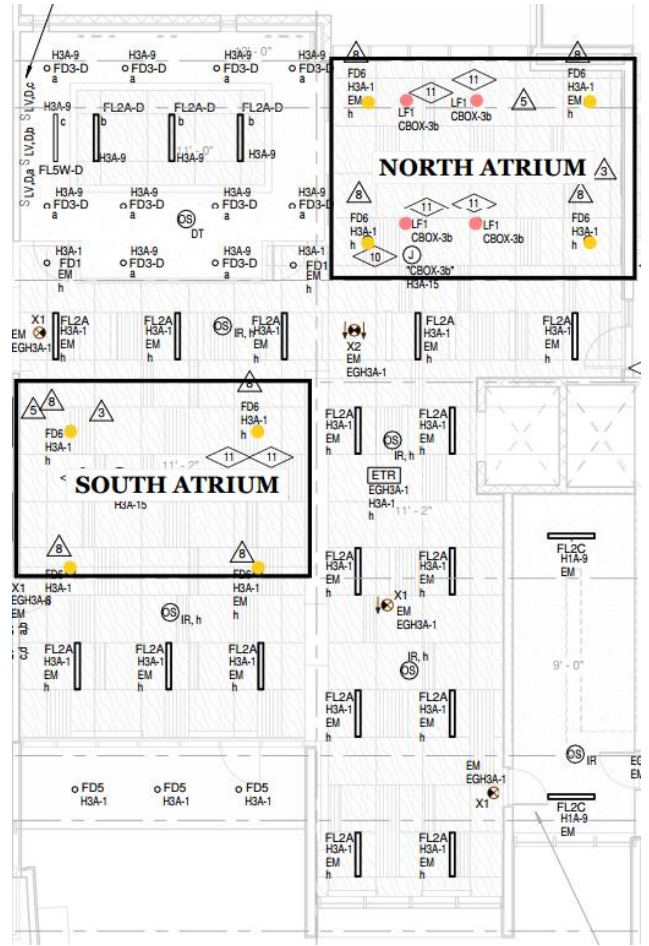


Figure 1.4.b | Third Floor Lighting Plan

Table 1.1 | Lobby/Atrium Fixture Schedule

Type	Description	Manufacturer	Model	Lamp	Load	Voltage	Notes
●	LUMENBEAM SURFACE MOUNTED LED LUMINAIRE, RGB OPTICS, DMX DIGITAL CONTROLLER	LUMENPULSE	LBL-277-RGB-NS-LSLV-BK-SY	LED RGB	50 VA	120 V	PROVIDE LUMINAIRE WITH LINEAR SPREAD LENS WITH VERTICAL DISTRIBUTIONS
■	LINEAR LED LIGHT STRIP, 24" LONG, CLEAR LENS, WHITE FINISH, SURFACE-IN-MILLWORK	LUCIFER	FLS-1-023-W-C-C	LED 4000K	4 VA	120 V	
■	2'0" LONG, NARROW APPERTURE RECESSED LUMINAIRE WITH OPAL LENS, MOUNTED VERTICALLY	VERSALUX	VL6	(1) 17W T8 4100K	20 VA	277 V	
■	8'0" LONG WALL MOUNTED ASSYMETRIC LUMINAIRE	FOCAL POINT	FAVCW-FL-1T5HO-1C-277V-L841-TS-8	(1) 54W T5HO 4100K	20 VA	277 V	
■	4'0" LONG, NARROW APPERTURE RECESSED LUMINAIRE WITH OPAL LENS	VERSALUX	VL6	(2) 32W T8 4100K	62 VA	277 V	
●	6" SQUARE DOWNLIGHT, HORIZONTAL LAMP, CLEAR GLASS LENS, DAMP LISTED	KIRLIN	FRS	(1) 26W TRT, 4-PIN 4100K	30 VA	277 V	
●	6" SQUARE WALLWASH, HORIZONTAL LAMP, CLEAR GLASS LENS, DAMP LISTED	KIRLIN	FRS	(1) 26W TRT, 4-PIN 4100K	30 VA	277 V	
●	11" OPEN DOWNLIGHT, HORIZONTAL LAMPS, DAMP LISTED, CUSTOM BLACK TRIM	KIRLIN	FRR-11021-99	(1) 57W TRT, 4-PIN 4100K	187 VA	277 V	

Design Criteria

The Lobby/Atrium mainly functions as a transition space, with a reception desk near the entrance. However, there is seating for leisure activities. In the IES Lighting Handbook, 10th edition, the task illuminances are as follows:

Table 1.2 | Lobby/Atrium Task Illuminance

Task	E_h (lux)	E_v (lux)	Avg:Min	Daylight
Transition				
Day	100	30	4:1	Y
Night	50	20	4:1	-
Reception	150	50	4:1	Y
Lounge	150	50	2:1	Y

It is also to be noted that this is the space in which I will be creating three lighting design schemes. The diverse architectural language allows for flexibility with design. There are also several features, including the atrium and a staircase, which can offer an aesthetic appeal to the lobby.

Since the lobby and atrium are the first thing that you see upon entering the building, it is important for it to appear welcoming and bright. The lobby also has a high power density, which can possibly be altered by changing the lamp sources.

Prioritized list of design criteria:

1. Aesthetic Appeal
2. Lighting Power Density
3. Illuminance Levels
4. Energy Savings

Evaluation

The lighting in the lobby is very functional, uniform, and bright. That being said, it could benefit from further creative lighting design. This could create a visual accent for those visiting or relaxing in the lobby.

The LPD for the lobby is to meet 1.10 w/ft² according to IECC 2012, and the existing lighting currently is over this recommendation, at 1.64 w/ft². As seen in my design criteria above, it may be worthwhile to incorporate LED fixtures into the lobby to accommodate the IECC. As a space that remains operating through the night, it could also help to increase energy savings

Spatial Description

Located on the second floor, the Multipurpose Room serves as an area for lecture, training, and presentations. This room also doubles as a command center when there is an emergency. The ceiling system slopes (see Figure 2.2) and the floor terraces to create optimal viewing. This space also contains Audio/Visual system, which is something to consider when designing controls.



Figure 2.1 | Multipurpose Room

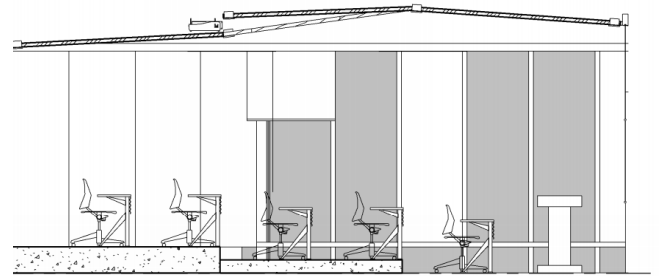


Figure 2.2 | Multipurpose Room Section

Tasks || Activities

Training
Reading
Writing
A/V Viewing

Dimensions

Area: 1792 SF
Ceiling Height: 10'-0," 12'0"
Room Length: 64'-0"
Room Width: 28'-0"

Materials

Ceiling: Wood Laminate, Gypsum
Walls: Gypsum, Composite Panels, Glass
Floor: 1x1 Carpet Tile

Furnishings

Rolling Chairs
Tables in Rows
Podium
Projection Screens

Existing Lighting Conditions

The lighting plans below indicate the fixtures located in the Multipurpose Room. The room utilizes recessed linear fluorescent fixtures as well as compact fluorescent downlights. Occupancy sensors are also present on the West and East sides of the rooms. The switching for the room is arranged in zones, and is also done with step dimming. The step dimming is arranged into 50%, 100% and all off.

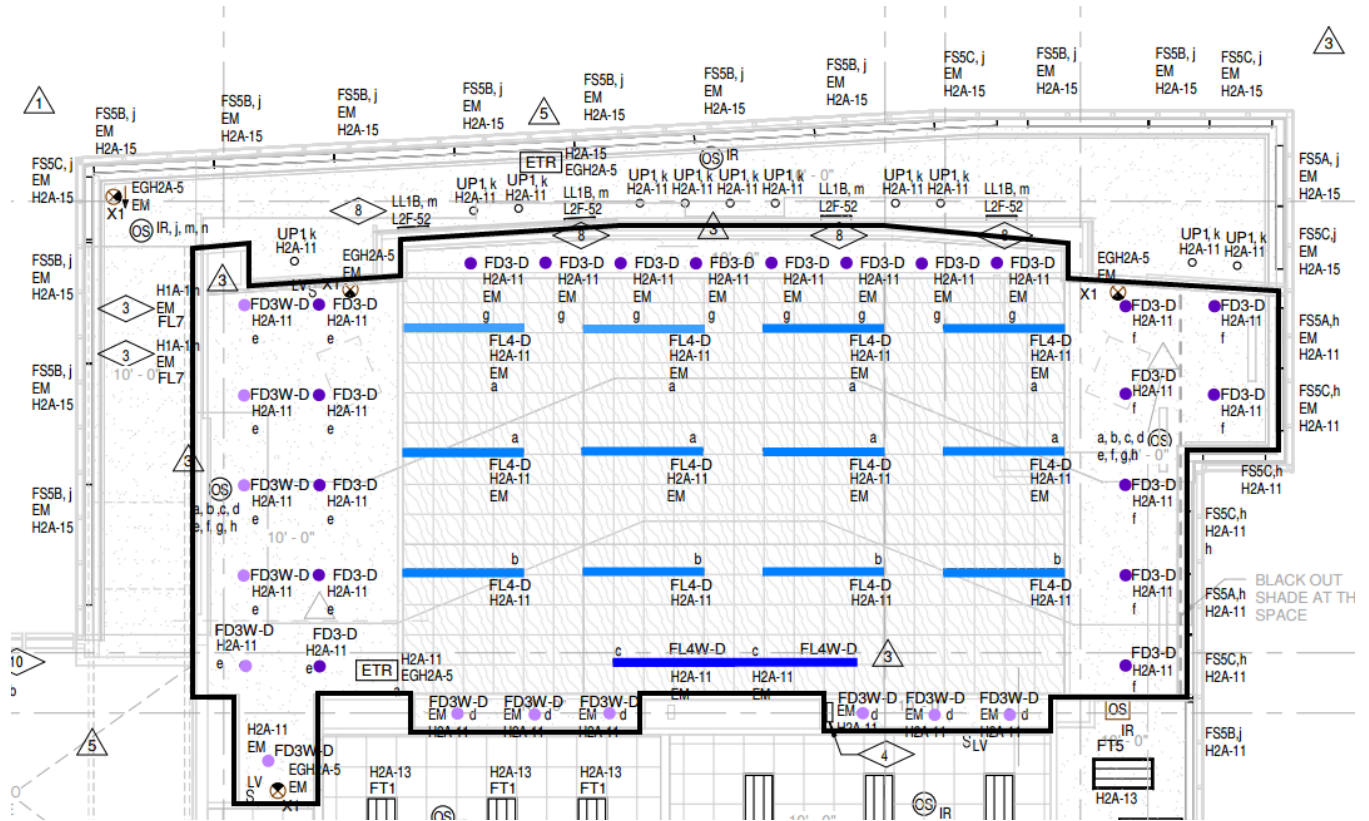
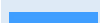





Figure 2.3 | Second Floor Lighting Plan
Multipurpose Room

Table 2.1 | Multipurpose Room Fixture Schedule

Type	Description	Manufacturer	Model	Lamp	Load	Voltage	Notes
	8'0" LONG, NARROW APPERTURE RECESSED LUMINAIRE, WITH OPAL LENS, DIMMING BALLAST, DAMP LISTED	VERSALUX	VL6	(4) 32W T8 4100K	124 VA	277 V	
	8'0" LONG, NARROW APPERTURE RECESSED WALLWASH, DIMMING BALLAST, DAMP LISTED	A LIGHT	D5_KA	(2) 32W T8 4100K	124 VA	277V	
	DIMMABLE 6" HORIZONTAL OPEN DOWNLIGHT, DIMMING BALLAST, DAMP LISTED, SELF FLANGED REFLECTOR	OMEGA	S6	(1) 26W TRT, 4-PIN 4100K	30VA	277V	
	DIMMABLE 6" HORIZONTAL OPEN WALLWASH DOWNLIGHT, DIMMING BALLAST, DAMP LISTED, SELF FLANGED REFLECTOR	OMEGA	S6	(1) 26W TRT, 4-PIN 4100K	30VA	277V	

Design Criteria

The Multipurpose Room functions as a training, lecture, and emergency command center. In the IES Lighting Handbook, 10th edition, the task illuminances are as follows:

Table 2.2 | Multipurpose Room Task Illuminance

Task	E _h (lux)	E _v (lux)	Avg:Min	Daylight
Reading & Writing	300	150	2:1	Y
A/V	50	15	2:1	N

It is very important for this space to have a wide range of controls. Since it functions as an emergency center and an A/V room, high and low light levels will be wanted. Manual dimming would also benefit this space to accommodate any emergency situations.

The current layout and amount of fixtures also exceed the recommended IECC 2012 lighting power density, so an alteration in lamp source may be considered.

Prioritized Design Criteria

1. Controls
2. Illuminance Levels at Task Planes
3. IECC 2012

Evaluation

The Multipurpose room consists of linear fluorescent and compact fluorescent fixtures which are all equipped with a dimming ballast. I believe that the controls for this room could be simplified, and also offer greater flexibility. In this room it is crucial to have optimal control due to the tasks that occur within it. Whether it be a basic learning seminar or an emergency center meeting, it will be important to have good control of the lighting within the room.

When calculated within AGI32, the average horizontal lux exceeded the recommendations by the IES handbook, but only by 35 lux. The ratio for average to minimum could use some tweaking, so I will pursue a layout adjustment.

Table 2.3 | Multipurpose Room Illuminance Summary Table

	Average E _h (lux)	Maximum E _h (lux)	Minimum E _h (lux)	Avg:Min
Calculation	335	520	110	3:1
IES Recommendation	300	-	-	2:1

For the calculations, a Light Loss Factor of 0.720 was applied to the recessed linear fixtures, while the downlights had a LLF of 0.727. The work plane for this room was set at 2'-6."

The LPD for the Multipurpose Room is to meet 1.30 w/ft² according to IECC 2012 under classroom, lecture, and training. With the current layout, the LPD is 1.40 w/ ft² so a more efficient design will be desired. AGI32 renderings are shown on the following page.



Figure 2.4 | Multipurpose Room Perspective

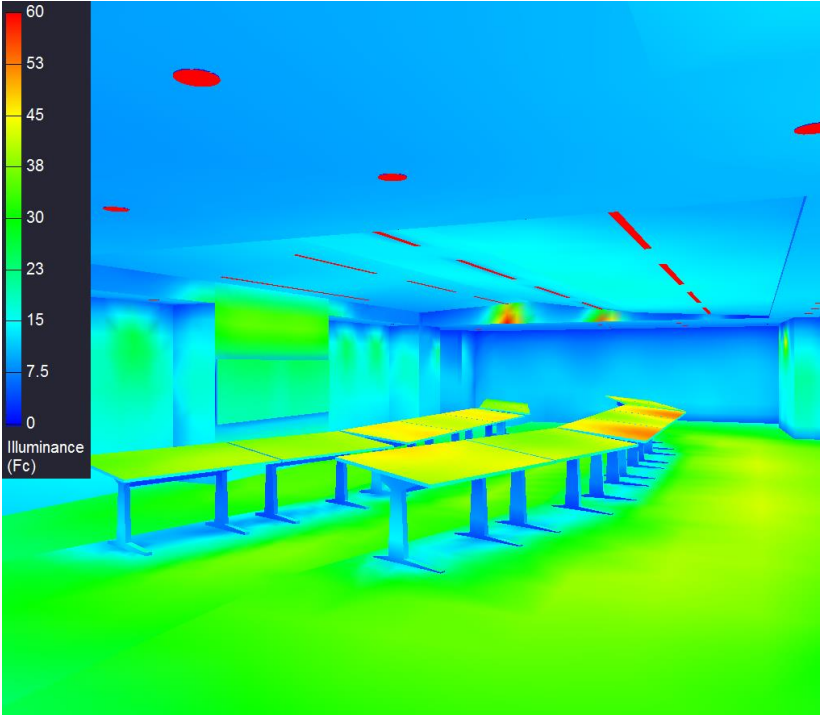


Figure 2.5 | Multipurpose Room Psuedo Color

Spatial Description

The Main DNA Lab on the second floor lab is where a lot of testing and careful investigation occur. The DNA Lab is a mostly rectangular room with seamless rubber tiles and a 10'-0" acoustic ceiling tile ceiling.



Figure 3.2 Main DNA Lab

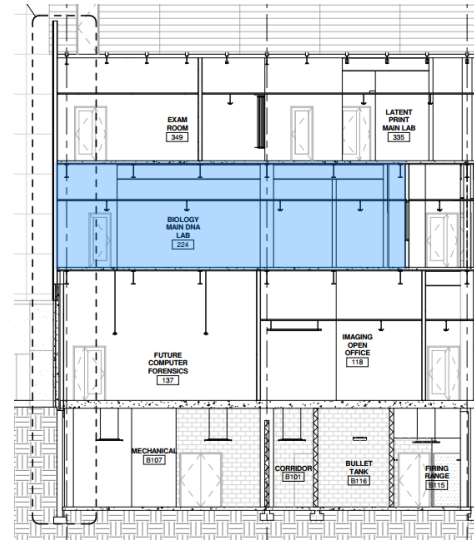


Figure 3.3 Main DNA Lab in Longitudinal Section

Tasks || Activities

Reading
Writing
Lab Work

Dimensions

Area: 2004 SF
Ceiling Height: 10'-0," 12'-0"
Room Length: 52'-6"
Room Width: 39'-0"

Materials

Ceiling: 2x2 ACT
Walls: Gypsum
Floor: Seamless Rubber

Furnishings

Chairs
Lab Tables
Lab Equipment

Existing Lighting Conditions

The lighting plans below indicate the fixtures located in the Main DNA Lab. The four-lamp linear fluorescent pendant fixtures are switched in zones of 50% lighting and 100% lighting. The fixtures themselves are 70/30 Direct/Indirect. There is no dimming present in the room.

The lab also contains infrared occupancy sensors, which will turn off all the lights when the room is left vacant.

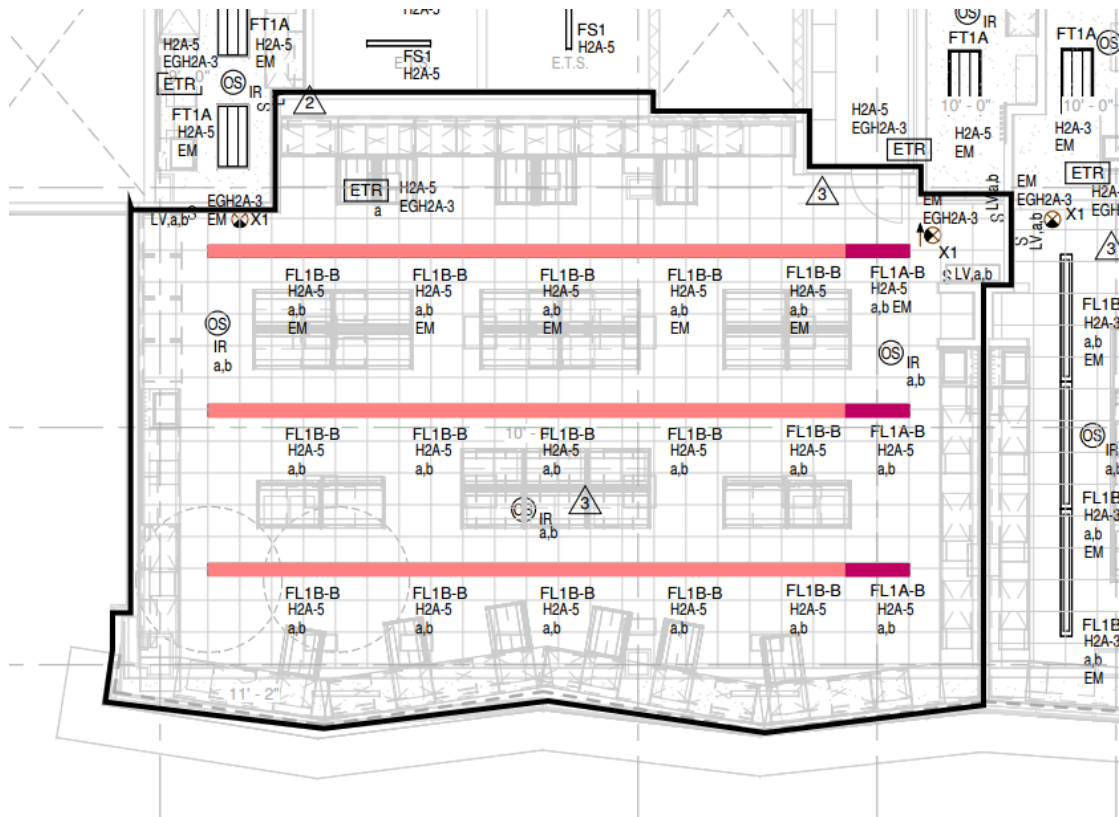
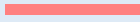



Figure 3.4 | Second Floor Lighting Plan
Main DNA Lab

Table 3.1 | Main DNA Lab Fixture Schedule

Type	Description	Manufacturer	Model	Lamp	Load	Voltage	Notes
	8'0" AIRCRAFT CABLE MOUNTED MICRO-LOUVERED DIRECT/INDIRECT, 70% DIRECT/30% INDIRECT, DUAL BALLASTS FOR DUAL LEVEL SWITCHING	PICASSO	FER-8-432-T8	(4) 32W T8 4100K	124 VA	277 V	SUSPENDED 18"
	4'0" AIRCRAFT CABLE MOUNTED WHITE CROSS BAFFLE, MICRO-LOUVERED DIRECT/INDIRECT, 70% DIRECT/30% INDIRECT, DUAL BALLASTS FOR DUAL LEVEL SWITCHING	PICASSO	FER-4-232-T8-CB	(2) 32W T8 4100K	62 VA	277V	SUSPENDED 18"

Design Criteria

The Main DNA Lab functions as a laboratory where bright light levels are needed to accurately assess results. In the IES Lighting Handbook, 10th edition, the task illuminances are as follows:

Table 3.2 | Main DNA Lab Task Illuminance

Task	E _h (lux)	E _v (lux)	Avg:Min	Daylight
Laboratory	500	150	2:1	Y

It will be important that the appropriate amount of light is provided in this space so that correct conclusions can be made regarding cases. It may also be useful to do a daylight study in this space as it is located in the southwest corner of the building.

In a lab with high-tech machines it is crucial to make sure there are no problems with wavelength interference. High power, blah

Prioritized List of Design Criteria:

1. Illuminance Levels – Average:Minimum
2. Uniformity
3. Lamp Type

Evaluation

The LPD for the Main DNA Lab is to 1.8 w/ft² according to IECC 2012 under laboratory for medical/industrial/research. The existing LPD is well within the bounds at 1.021 w/ft².

The Average:Minimum ratio could use major improvement. The current ratio is 11:1 which is far from the IES recommended 2:1. Balancing the light levels will provide a more uniform aesthetic in the room.

Table 3.3 | Main DNA Lab Illuminance Summary Table

	Average E _h (lux)	Maximum E _h (lux)	Minimum E _h (lux)	Avg:Min
Calculation	550	800	50	11:1
IES Recommendation	500	-	-	2:1

A Light Loss Factor of 0.63 was applied to the fluorescent pendants. The work plane was set at 3'-0" for the laboratory due to the standard height of the benches. AGI32 renderings are shown on the following page.



Figure 3.5 | Rendering of Transverse Section

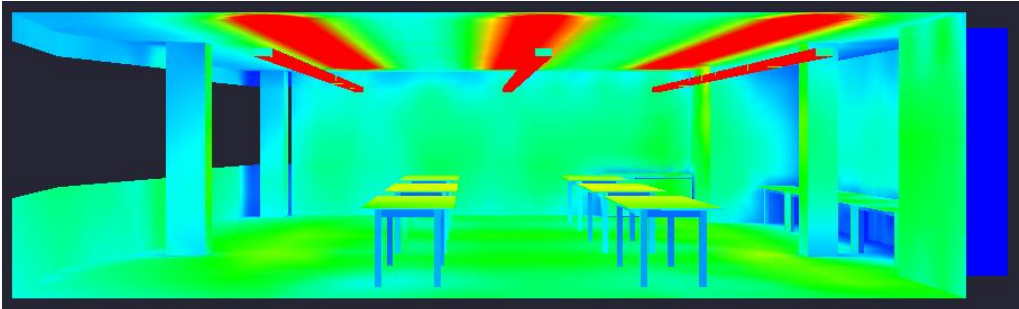
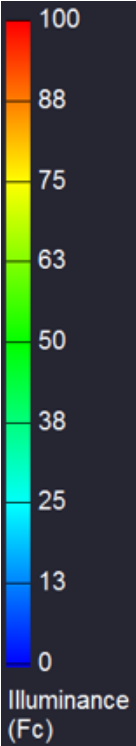


Figure 3.6 | Psuedo Color of Transverse Section



The South Plaza connects the Denver Police Department Crime Lab to the main plaza where the Denver Police Department. The plaza has colored concrete tile and concrete walls for seating, as well as vegetation for a varied landscape.

Spatial Description

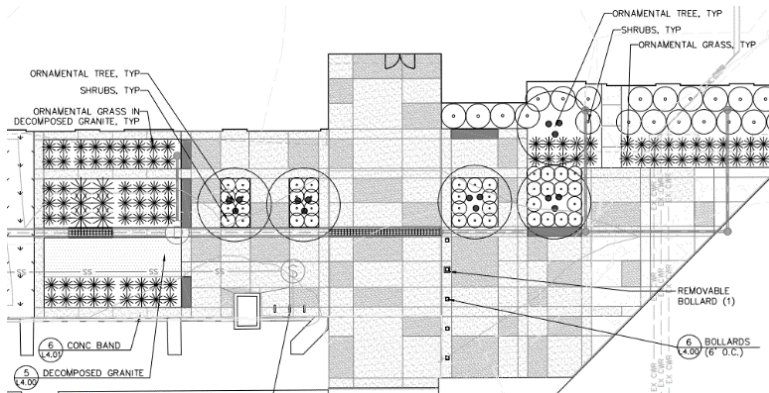


Figure 4.1 | Bird's Eye View of Concrete Pattern and Vegetation Arrangement

Tasks || Activities

Transition
Lounge

Materials

Ceiling: N/A
South Façade of Crime Lab: Frosted Glass, Frit Glass, Metal Panels
Floor: Colored Concrete

Dimensions

Area: 6094 SF
Ceiling Height: N/A
Room Length: 92'-0"
Room Width: 66'-6"

Furnishings

Concrete Seat Wall
Trees
Shrubs
Bike Rack

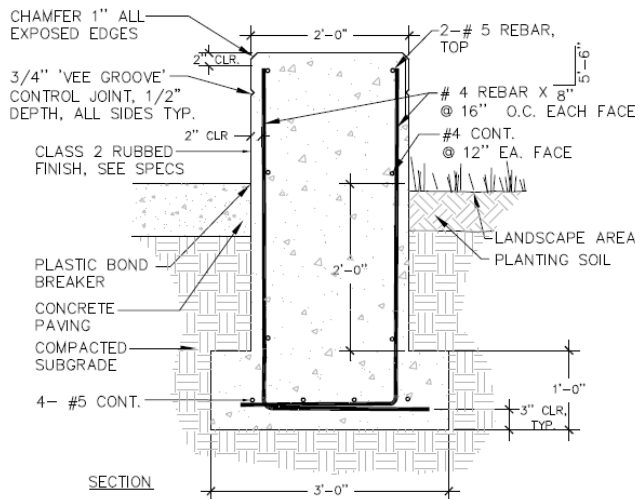


Figure 4.2 | Concrete Seat Wall Detail

- NOTE:
1. WALL: 4,000 PSI, .45 W/C, TYPE I/II CEMENT.
 2. FOOTING: 3,000 PSI, .52 W/C, TYPE I/II CEMENT.
 3. PROVIDE SHOP DRAWINGS PRIOR TO FORMING AND INSTALLATIO

Existing Lighting Conditions

The lighting plans below indicate the fixtures located in the South Plaza. The plaza consists of nine bollards that do not require a crash rating. The controls are on a time clock and set to turn the bollards on at 6:00 PM and turn them off at 7:00 AM.



Figure 4.3 | Site Lighting Plan
South Plaza

Table 4.1 | South Plaza Fixture Schedule

Type	Description	Manufacturer	Model	Lamp	Load	Voltage	Notes
■	SITE ILLUMINATED BOLLARD	FORMS+SURFACES	KNIGHT BOLLARD	(1) 26W TRT 4-PIN 4100K	30 VA	277 V	

Design Criteria

The South Plaza functions as a transition space where employees and enforcement enter the building. The plaza is classified within Lighting Zone 4, due to its location in downtown Denver, and has a medium amount of nighttime activity. In the IES Lighting Handbook, 10th edition, the task illuminances are as follows:

Table 4.2 | Outdoor Space Task Illuminance

Task	E_h (lux)	E_v (lux)	Avg:Min	Daylight
Transition – Plaza	6	2	5:1	-

As transitional space, and one can that often be stressful, I have decided to use a psychological impression to transform this space. My goal would be to create an outdoor space that embodies calm and relaxation. The Crime Lab is open nearly 24/7, with employees working day and night shifts. It is for this reason that I believe the South Plaza could become a relaxing destination for employees. Creating a calm space will be a positive for this project, but it must remain a safe area due to the nature of the occupation. Finding the right balance between darkness and light in this space may prove to be a challenge. Light trespass can also become an issue with exterior lighting, so that will also be studied.

Prioritized list of Design Criteria:

1. Psychological Impression
2. Illuminance Levels – Safety
3. Light Trespass
4. IECC 2012

Evaluation

The South Plaza is lit solely by nine compact fluorescent bollards. While simple can be pleasant, I believe this lighting design can be greatly improved upon in order to achieve a psychological impression.

According to the IECC 2012, the South Plaza falls into Lighting Zone 4, which is a high-activity commercial district. This means that for the LPD, the plaza gets a base allowance of 1300 W and 0.2 w/ft² since it is larger than 10 feet wide. Currently the outdoor space is well within the limits at 0.04 w/ft² with a total wattage of 0.0443.