BYU ENGINEERING
Civil & Construction Engineering

CAPSTONE

LOW RISE REINFORCED CONCRETE HOTEL
PROJECT ID: CEEN_CPST_009

by

CABStone
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A Capstone Project Structural Report

Submitted to

Taylor Sorensen, PhD
With the Concrete Reinforcing Steel Institute

Department of Civil and Construction Engineering
Brigham Young University

April 11, 2022

Executive Summary

PROJECT TITLE: LOW RISE REINFORCED CONCRETE HOTEL
PROJECT ID: CEEn_CPST_009
PROJECT SPONSOR: Dr. Taylor Sorenson
TEAM NAME: CABStone

The project consists of the design of a 6-story low-rise hotel in an area of low seismic risk in Schaumburg, Illinois. We were given architectural plans and required to design and create structural plans for the building. The tasks for this project included the following: calculate dead and live loads, design an economical floor system, determine sizing for columns between the floors and the drilled shaft deep foundation, and create structural drawings for the project.

The project was scheduled and completed over the course of Winter Semester 2022 (a span of twelve weeks). The objectives of our project include applying knowledge of mathematics, science, and engineering; communicating effectively; learning to function on multidisciplinary teams; and understanding the impact of engineering solutions in a global, economic, environmental, and societal context.

A general schedule is given below, with a more detailed outline presented later in the report:

- January: review provided PowerPoints listing specifications, details, and information needed for the project
- February: calculate dead and live loads
- March: design floor systems and determine sizing for columns and foundation
- April: put final touches on poster and report; give project presentation to faculty mentor and sponsor

The deliverable for this project is a full set of structural drawings (with relevant details). These drawings will outline our choices and calculations for the building including live and dead loads, economical floor system, and foundation size as mentioned above as well as reinforced column and beam sizing and complete construction drawings. Deliverables for the capstone course include weekly status reports, timecards, a progress report, and a final report including a presentation poster. These are to be completed and turned in the first week of April.

Table of Contents

Introduction

For this project, we were responsible for creating structural plans based off of given architectural plans for a six-story concrete hotel building. The building is located in an area of low seismic activity close to Chicago. The project included three main tasks that were performed throughout the course of the semester: calculate live and dead loads acting on the structure, determine preliminary sizes for the foundations and reinforced concrete columns and beams, and create structural plans in AutoCAD to present as a final product.

These tasks were divided into twelve weeks of work and were completed over the course of the semester. Team members averaged around eight hours of work a week in order to achieve our goals. The project was broken into three major sections, with the correlated tasks listed below:

1) Introduction/Overview of Project and Schematic Design Phase (month 1)
    a. Calculate live and dead loads acting on the hotel
    b. Find snow and rain loads
2) Design development phase (months 2-3)
    a. Calculate sizes and reinforcement for beams and columns used in project
    b. Look at economical floor systems
    c. Determine foundation size
3) Construction Documents Phase
    a. AutoCAD drawings (months 2-3)
    b. Documentation of calculations
    c. Final report

Part 1 consisted of some basic calculations for the live and dead loads acting on the building. It entailed searching through ASCE code to find the weights to consider for various building materials and an assortment of live loads caused by objects and people in the hotel. We also performed research on how to calculate snow and rain loads, including predicted rain- and snowfall in Schaumburg, IL.

For Part 2, Christian created a detailed spreadsheet to assist in designing the beams and columns for the hotel. Once we had the spreadsheet, we were able to start from the roof and calculate down to the base for columns, beams, and a foundation. We met together as a group to complete many of these calculations.

Part 3 consisted of documenting our calculations and processes in a way that is easy to follow, as well as creating the final products required for our project. We created structural plans using AutoCAD 2022 by uploading PDFs of the architectural plans and using the walls in those plans as a base for the structural elements. As we worked on calculations, we kept careful track of assumptions made and the numbers we used so others could review our work. In part 3, we worked on writing down those assumptions and calculations in this report.

To create a finished product for this capstone project, we were required to make some basic assumptions about the materials and the structure of the building in general. We also made several assumptions about the hotel structure in order to simplify the project to a manageable scope. A list of assumptions that affected the results of our calculations are detailed later in the report. Below are listed the assumed or given properties of concrete that were used in designing the structure:

fc	4 ksi/ 6 ksi
fy	60 ksi/ 80 ksi
unit weight of concrete	150 pcf

Table 1 Concrete Properties

Our capstone project is slightly unique in that it was actually designed to be a 3 credit-hour course for graduating seniors, rather than being a real-world issue presented by a company. The building is only being designed for the purposes of the course, and it follows the protocols and codes as designated by the course material. The expectations and requirements of the project were provided by the course and refined by Dr. Sorenson and ourselves as we worked on the project throughout the semester. Our deliverables include the structural plans for the concrete hotel and a report showing the calculations and documentation on how the calculations were completed. As the project continued, we updated Dr. Sorenson on our progress and made adaptations as necessary to the project so we could reasonably finish the amount on work by the deadline.

Schedule

Below is presented a timeline including important milestones, accomplishments, and challenges. It is in order from oldest to most recent (when the project was completed).

- Fall Semester 2021
  - October 18, 2021
    - Met with Dr. Sorenson; he introduced our capstone project to us, and we discussed the purpose and concept of the project
  - November 22, 2021
    - Statement of Work due (scope of project and plan to complete it)
- January 2022
  - Started off second semester by reviewing the course PowerPoints, which were designed to give explanations and assumptions for our project
  - Began calculating loads as the first step to the project
  - Met with Dr. Sorenson to discuss project progress
- February 2022
  - Met with Dr. Sorenson and Dr. Mitchell to redefine scope of project
  - Finished calculating live and dead loads on the building
  - Began drawing AutoCAD structural plans; created footprint with walls
  - Made spreadsheet to size beams, foundations, columns, and slabs
- March 1, 2022
  - First calculation night; sized beams for roof with spreadsheet
- March 10, 2022
  - Scrapped the work we did with beams/girders and restarted using slabs. Calculations completed for the roof and floors 1-6 slabs.
- Week of March 14
  - Finished the column calculations
- March 21
  - Progress report completed and turned in (60% completed)
- March 28
  - Final calculations completed
- April 4
  - Poster due
- April 7
  - Presented capstone project in seminar, and to faculty mentor/sponsor
- April 11
  - Final report turned in to capstone advisors and faculty mentor/sponsor

Assumptions & Limitations

Below is a list of assumptions we made while designing the structural elements for the six-story concrete hotel:

- Project Assumptions
    - Construction completed in Schaumberg, IL, an area of low seismic activity. Because of this, the effects of seismic loads were ignored.
    - This project does not address wind loads or include the sizing of shear walls and lateral reinforcement.
    - The design for the ballroom, stairwells, and elevator shafts were not included in the scope of the project.
    - All design calculations were computed by hand and within Excel.
- Roof Design Assumptions
    - Secondary drainage occurs at three inches above the roof drain (for purposes of estimating rain load).
        - Assumption based off of NOAA data (25-year, 24-hour storm has rainfall intensity of 5.2 in/hr)
    - Dead load of HVAC was assumed to be 50 kip, located in the center of the roof, and modeled as a point load
    - For conservative analysis, we disregarded effect of moments that would decrease the overall load on the beam (i.e. roof anchors and davits)
- Slab Design Assumptions
    - First floor slab was assumed to be suspended, but it was also supported by the soil beneath it.
- Column Design Assumptions
    - A lateral force was assumed for the columns for the shear design.
    - We assumed an offset of the loads that caused a moment on the columns. This is the e_x and e_y seen in the calculations.
- Foundation Design Assumptions
    - No bell on bottom of drilled pier
    - No skin friction (no geotechnical information given)
    - Assumed 5000 psf allowable bearing capacity for cap

Design, Analysis & Results

The design process utilized in the development of the structural drawings is the typical design process implemented by most structural engineering firms. The first step in the process was to gain a firm understanding of the scope and outline of the project. For example, we learned that the scope of the project was to design and draft only parts of the building and not the entire building. Also, we learned that there were mechanical components that did not need to be included in the design, such as the elevators. Secondly, we analyzed the architectural drawings to make sure we account for any non-ordinary structural components. For example, we saw davit systems and a heavy HVAC system on the roof that needed to be accounted for. The figure below shows an example of the architectural drawings that we analyzed before designing the structural members. In this drawing, the davit systems were marked with the red lines and the HVAC system on the roof that needed to be accounted for.

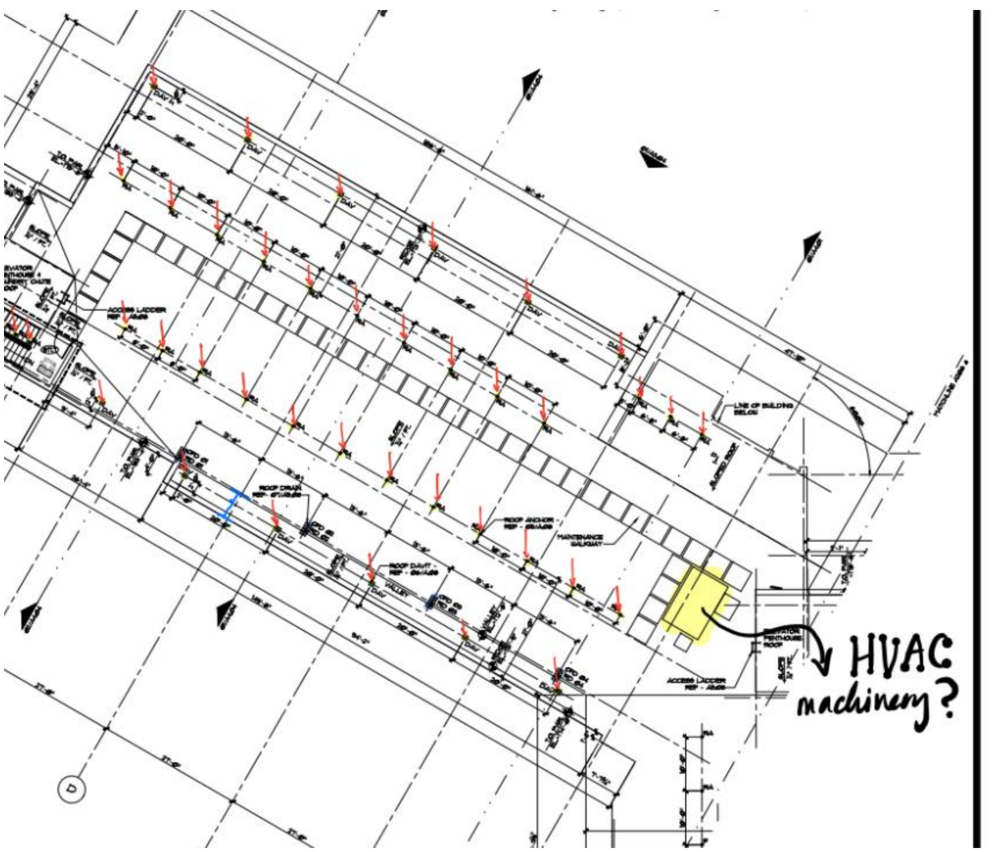

Figure D.1: Example of Architectural Drawings

Third we defined the loads that are present on each floor. These included live loads, dead loads, snow loads, and parapet snow loads. Initially, we started our design assuming that we would use T-beams for catching the floor system loads. The T-beams would transfer their loads to girder beams. The girder beams would then transfer their loads to the columns and eventually to the floor. However, using this system would cause conflicts with the architectural design. For example, beams would dip too far into the area assigned for the doors. Sheridan consulted with a professional engineer in the structural department at the firm she works at, and he recommended using a slab system. Thus, our renewed method of transferring the loads was to transfer loads from slabs to columns to the piers, and then to the sub ground layer.

For simplicity, economic reasons, and to fulfill the basic requirement of this project to learn the design process, we only took into account the worst-case scenarios in the design of each member. Economically, this saved money with form work. It accomplished the design of this project in that we gained experience tracking loads and going through the design process. Figure D.2, showing area B on the sixth floor, is an example of defining the loads on each floor system. The loads were decided based on the code, with different loads representing different uses of the structure or other categories it fell into.

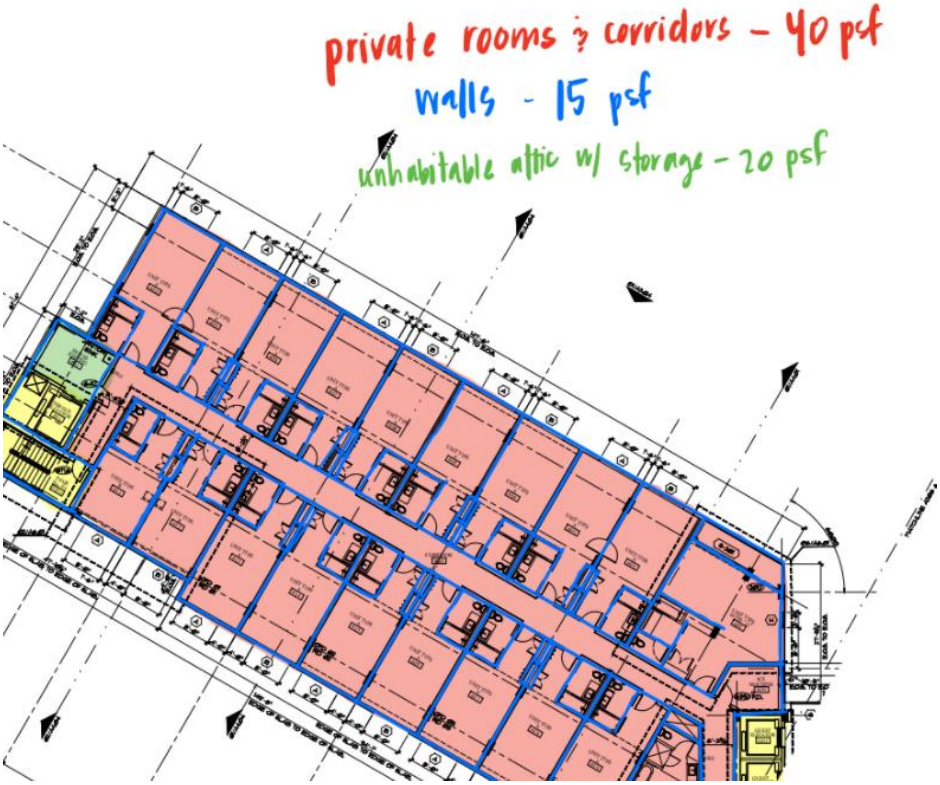

Figure D.2: Load Example

Finally, we created the structural drawings and details to convey to the construction manager how things are to be constructed. The structural drawings include the outlines of exterior and interior walls. They also include the labels for the different column and slab sizes, so the contractors know what is to be constructed where. The details outline the placing of reinforcement and the size of structural members. They also define the size of longitudinal, shrinkage, and shear reinforcement sizing. These details are provided to give the contractor greater specifics as to how the design of members should be accomplished. The figure below is an example of a part of a page from the structural drawings. It is located on the ground floor and shows the dimensions for where the columns are located.

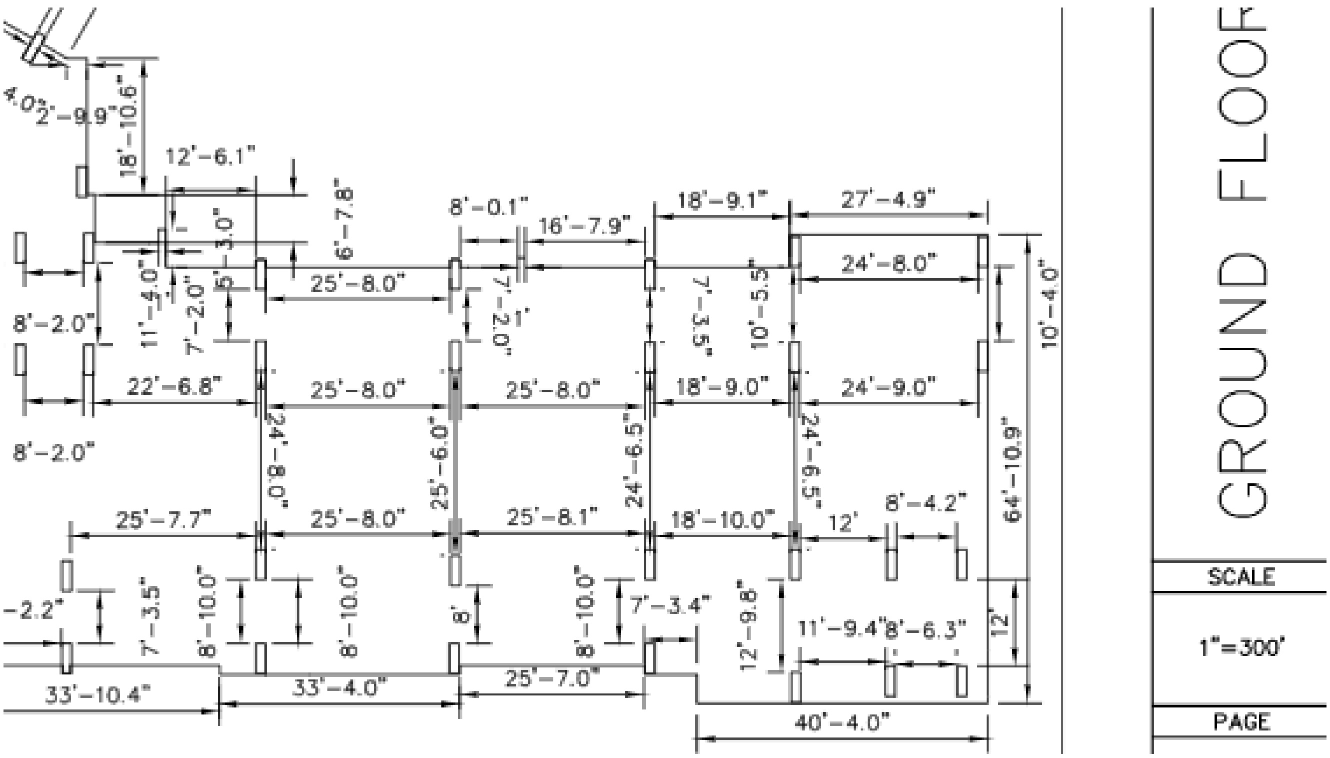

Figure D.3: Ground floor column locations

Figure D.4 shows an example of detail for the columns. It shows a side view of the column with the location of the slabs of each floor. On the left side it shows the stirrups, the placement of stirrups, and the initial distance from the edge where the first stirrups need to be placed.

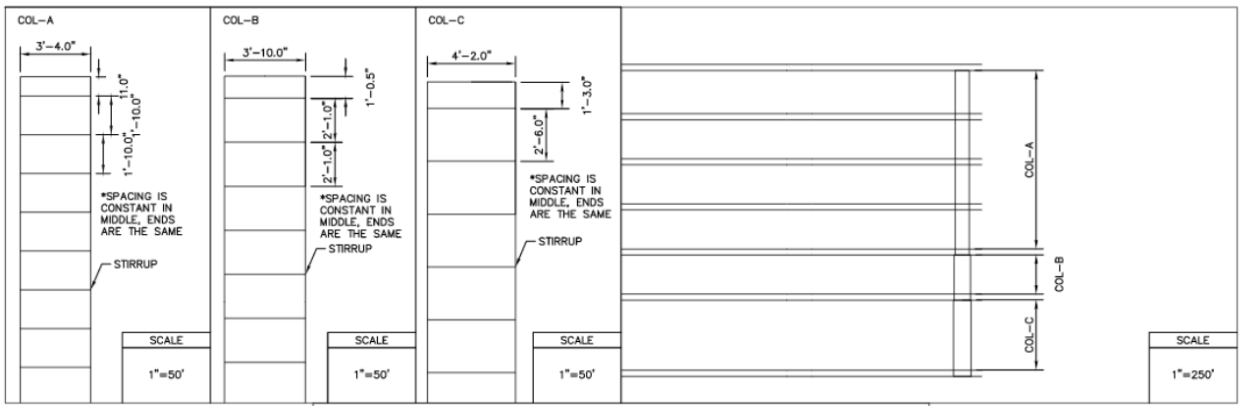

Figure D.4: Example of Structural Detail

Related Issues

As with any civil engineering project, our six-story concrete hotel had a large impact on the area surrounding it. Civil engineering projects are not completed in a vacuum – every decision made on this building had implications on factors such as public health, the environment, and the social atmosphere of Schaumburg, Illinois. This section is an attempt to document some of the consequences of our construction on various areas of concern.

- Public health – Constructing a large building in the middle of an already fairly populated city can certainly have an effect on the public health of the people living in the area. Construction can cause a lot of air and noise pollution. In consideration of this, we decided to use drilled shafts rather than driven piles in the foundation. Driven piles can cause a lot of noise and can take a long time to install. For this project, we decided to reduce noise pollution by using caissons. The air pollution caused by the fully constructed hotel should be minimal and should not negatively impact the vicinity any more than other houses and businesses in the area.
- Safety and Welfare – The purpose of our project was to create the structural plans for a hotel given based on a given design from an architect. Because of that, we had the capability (and responsibility) to construct the hotel with very high safety standards. We used conservative estimates in our loadings when designing the components of the hotel. We first calculated all of the potential dead and live loads and then considered combinations of those loads, knowing that multiple loads will act on the building at one time. When considering potential loads, we followed the code and used the highest load combination, which incorporated a factor of safety, for a more conservative estimate and to ensure the safety of the hotel. Because the area is not seismically active, we do not have to worry about the collapse of the structure in the event of an earthquake.
- Environmental factors – We used a very economic approach in an attempt to cut costs and make the project as cost-effective as possible. This also had benefits for environmental considerations. Because we used the same formwork throughout the project to save money, we also needed the construction equipment on site for less time, which reduced pollution from the machinery.
- Environmental factors (cont.) – Erosion Control Plan – In order to mitigate the environmental impact of the construction on the surrounding area, an erosion control plan and Storm Water Pollution Prevention Plan (SWPPP) were compiled. As a full site plan for the hotel was not provided, some assumptions regarding site conditions were made. Schaumberg, IL was found to be part of the Chicago/Calumet watershed. Storm

water Best Management Practices (BMPs) were delineated to prevent water pollution entering this watershed. Some of these BMPs include the installation of a silt fence, wheel wash, inlet protection, and portable toilets. Existing vegetation is also to be protected to avoid erosion. The full SWPPP report and erosion control map can be found in the Appendix.

- Social Factors – The construction of a hotel brings both welcome and unwelcome social consequences. As tourism increases in an area, so does the demand for hotels. As hotels are built, it attracts more people and increases the capacity for tourism, creating a cycle that can make a city more productive. Schaumburg is a suburb outside of Chicago, so it is already very close to a large (and dangerous) city. However, living in a nearby suburb is a good option for families or individuals that want to stay away from the hustle and bustle of the city while still living near enough to access the city. Building a hotel in the suburb could increase the amount of city traffic coming through Schaumburg, which could be detrimental for people trying to avoid the big city. On the other hand, a hotel provides a good opportunity for the growth of the city. As more people come to visit the city, it allows the city to grow to accommodate the increase of visitors. More restaurants and social opportunities could become available to those living in Schaumburg.
- Economic – This project is intended to be economically beneficial. It is obviously an investment because a large building such as this will cost a lot of money up front to construct. However, the design of the project was created intentionally to decrease the overall costs of the project. After calculating loads acting on the building, we looked at the worst-case scenario and used that to design our slabs in between floors and the columns holding up each floor. This allowed us to create a very economical design. While the materials cost increased slightly since some of the columns were unnecessarily large, the labor cost decreased by much more. It takes a lot more time, money, and energy to figure out complicated structural plans with differing column diameters and rebar amounts than to look at simple plans with the same design throughout the whole building. In addition, even the architectural plans were very similar for floors two through six. This also allowed us to use the same formwork throughout the construction, which saved even more on labor costs.
- Economic (cont.) - The city can earn more money as more outsiders come to stay, buy food, attend local events, and more. This creates income for the city, which can be put back into the city to improve facilities and infrastructure. A hotel is a good way to increase the capacity for tourism and it encourages businesses and other organizations to consider holding conferences or events in the area, which brings even more external income.

Lessons Learned

1) Overcoming initial steep learning curve caused by lack of experience

We initially had a lot of difficulty while working on the project due to our overall inexperience with structural design projects. We spoke with Dr. Sorenson, and he gave some instruction on how to solve for the first calculations of the project, but we quickly realized that he would not be available to help us with every question we encountered. We struggled through the initial calculations while consulting the provided PowerPoints and other project material and barely finished some basic computations for the loads acting on the hotel. Eventually we decided to schedule a time to meet up with both Dr. Sorenson (our faculty mentor/sponsor) and Dr. Mitchell (our capstone advisor) to gain a better understanding of the project expectations and to communicate our issues.

After the meeting, we felt much more prepared to move forward and we finished the rest of the project without major issues. One key takeaway for us was learning in an unfamiliar situation how to recognize what we *do* know and being able to put that into practice. Another crucial lesson we learned was how to communicate with our superiors in order to establish expectations, share challenges, and find appropriate solutions so we are all on the same page and understand why progress is or is not happening on the project.

2) Team member without experience

Having a team member with very little structural experience was a challenge because almost every calculation needed for the hotel centered around reinforced concrete, so there was little she knew how to do for the structural design aspect of the project. She worked on tasks that did not involve much math related to the reinforced concrete design, such as beginning the structural drawings and designing the caissons. The key lesson we learned from this experience is that we all had different talents and knowledge to contribute. We also learned from this experience that teams are essential to doing good engineering work; we can rely on each other and learn from each other's expertise.

3) Correcting mistakes

We started the floor systems by calculating beams and girders, but consulted with a structural engineer and switched to slabs at his recommendation. We had to start our calculations over from the beginning and not waste time worrying about the hours we had lost to faulty calculations. The lesson we learned from this experience was the importance of going back and fixing mistakes instead of glossing over them to save time. Our column and foundation calculations were dependent on the slabs we designed, so it was very important to get that correct. Another thing we learned was how helpful it is to consult those with more experience.

Conclusions and Recommendations

The first conclusion we made was that calculating dead and live loads accurately is an essential first step to designing a building appropriately. We initially wanted to make a very conservative design by using larger loads, but that left us with unrealistically thick columns. Finding the worst-case scenario at one point on the roof and applying it everywhere was a safe approach, but a bad idea for the whole building.

We also concluded that using a slab for the floor system was better in this situation than using beams and girders. After hours of calculating potential beam and girder sizes, we realized that the most economical approach would be to use a slab instead. Another conclusion we made was the importance of a deep foundation. We were told that the soil directly beneath the building was loose and had low strength, so excavation and replacement of the weak soil would have been extremely expensive and time intensive. Bypassing the weak soil with caissons was a better solution.

Lastly, we concluded that in order to make our design as economical as possible, we wanted to use the same column and drilled shaft size throughout the design. We used the calculated loads to find the largest required column size, and then used that same column throughout the entire floor. The column was in some cases larger than needed, but the money lost in materials cost was negligible compared to the money saved in labor cost.

For recommendations, as stated in the design and analysis section above, we suggest our structural design including a reinforced concrete slab system with rectangular columns and caisson foundations. We believe our analysis to be sound and our results reasonable when compared to real-life standards.

Going forward, we recommend that additional analysis in done in order to complete the structural plans for the hotel. Analysis is still required on aspects of the design outside of the scope of the project including the ballroom, elevator shafts, stairwells, and shear walls and lateral reinforcement. Determination of wind loads must also be completed in order to check that our proposed design will be able to withstand all loads. It is probable that our design is somewhat overdesigned. We used thick slab sizes and large reinforcing bars. Doing a more in-depth analysis of loads, perhaps using a computer program, may allow the design to be slimmed down and more economical.

Additionally, the structural plans must be reviewed and revised by the developer and city planning commission. The design may have to be adjusted based on comments from the architect or planning commission. The design would also need to be looked over, approved, and stamped by a professional engineer. While our design is a valid first step in the design and construction process, much more analysis should be completed before the actual structure is constructed.

List of Appendices

Appendix A

Team Member Resumes

Anna Gillespie
(385) 289-7540 · agilles321@gmail.com

EDUCATION

Brigham Young University Apr 2022
Bachelor of Science: Civil Engineering Provo, UT

- GPA 4.00
- Awarded full tuition scholarship by BYU
- Pursuing Dutch Language Certificate; Projected Completion: April 2022
- Relevant coursework: Structural Analysis, Foundation Engineering, Soil Mechanics, CAD/Revit Drafting

EXPERIENCE

BYU Civil and Construction Engineering Department Sep 2019-Present
Engineering Statics and Dynamics Teaching Assistant Provo, UT

- Lead six TAs in meetings, facilitate communication between TAs and the instructor, and delegate tasks
- Instruct and coach students in learning engineering concepts and solving problems
- Evaluate students' work: provide feedback and assign grades for over 100 students

BYU Civil and Construction Engineering Department May 2021-August 2021
Geotechnical Research Assistant Provo, UT

- Organized and analyzed hundreds of data points that were continuously measured and recorded on-site
- Communicated clearly and punctually with researchers in both America and Italy
- Drafted written reports on research being completed in preparation for future published papers
- Utilized AutoCAD to create drawings and maps with a professional appearance

BYU Civil and Construction Engineering Department Jan 2021-Jun 2021
Water Resource/Hydraulics Research Assistant Provo, UT

- Located and documented low head dams using Google Earth Pro to prevent potential casualties
- Worked cohesively with a team of about seven students to organize and complete workload by deadlines

BYU Space Management May 2020-December 2020
CAD/Revit Technician Provo, UT

- Updated changes in the AutoCAD and Revit files of university campus building floorplans
- Accurately completed on-site measurements in order to verify existing floorplans
- Designed alternate layouts for over 300 university classrooms to comply with COVID-19 restrictions

VOLUNTEER EXPERIENCE

Church of Jesus Christ of Latter-Day Saints Jul 2017-Jan 2019
Full-Time Representative The Netherlands

- Planned and taught lessons, organized and taught English to speakers of other languages, led and trained other representatives, set and followed up on goals, translated communications between Dutch and English

PROFESSIONAL AFFILIATIONS

- American Society of Civil Engineers (BYU Chapter)
- Women in Civil Engineering (BYU club)

TECHNICAL SKILLS /ABILITIES

- Competent in Revit, AutoCAD, Excel, ArcGIS, Google Earth Pro, VBA, and other software tools
- Outstanding communicator – oral and written
- Ability to work well on a team, and collaborate with other people

INTERESTS/ACHIEVEMENTS

- Experience in foreign cultures and languages: fluent in Dutch, proficient in Italian

Brendon Allred

(928) 279-4432 · bpallred@gmail.com · www.linkedin.com/in/brendonallred

EDUCATION

Bachelor of Science in Civil Engineering
Brigham Young University — Apr 2022

- GPA 3.78/4.0 — *Provo, UT*
- Full Academic Scholarship 2019-2020
- Member of the American Society of Civil Engineers Student Chapter
- Relevant Coursework: Statics, Dynamics, Mechanics of Materials, Fluids, Intro to Transportation, Structures, Engineering Drafting, Materials, Concrete, Masonry & Asphalt, Fundamentals of GeoTechnical Engineering, Reinforced Concrete, Traffic Engineering, Engineering Applications of GIS
- Proficient in: AutoCAD, Revit, ARC GIS Pro, Synchro, Sidra, and Virtual Basic Excel Programming

RELEVANT EXPERIENCE

Kimley-Horn — May 2021-Aug 2021
Civil Engineering Intern — *Kingman, AZ*

- Produce 10+ traffic studies using trip generation, trip distribution, trip assignment, participation calculations, left turn storage analysis, level of service analysis, and queuing analysis
- Conducted traffic counts at 37 different locations throughout the Las Vegas Valley
- Utilized AutoCAD to display the results of our analysis neatly and clearly
- Used Visual Basic coding in Microsoft Excel to reduce time on analysis and data reduction
- Generated 10+ Synchro models to perform level of service analyses

American Woodmark — May 2019-Aug 2019
Engineering Intern — *Kingman, AZ*

- Generated serial numbers and barcodes for 400+ drums to scan into a database
- Created and updated a database to organize barcode information for an automated ordering system
- Collected data on defective products to identify where defects occur
- Brainstormed ideas and ran tests to make company processes more efficient
- Participated in team events to organize work areas, and improve processes

EXPERIENCE

BYU Automotive Shop — Jan 2019-Present
Technician — *Provo, UT*

- Perform required maintenance on BYU fleet vehicles
- Perform oil changes, brake service, tires replacement, alignments, and other general maintenance
- Practice proper lifting technics of vehicles with a jack and jack stands, two post lifts, and scissor lifts
- Develop previously acquired knowledge as a technician

Bulldog Disposal — Jun 2014-Aug 2016
Laborer — *Kingman, AZ*

- Purchased metals from customers and interacted with frustrated customers in a dignified manner
- Used a data input system to categorize vehicles by the year, make, model, VIN, and body style

VOLUNTEER EXPERIENCE

The Church of Jesus Christ of Latter-day Saints — Aug 2016-Aug 2018
Full Time Volunteer Representative — *Atlanta, Georgia*

- Led 16+ other representatives in organizing volunteer efforts to increase productivity
- Supervised other representatives and ensured procedures were followed
- Conducted weekly meetings with individuals to train volunteers
- Participated in various community outreach service projects to help others in need

INTERESTS/ACHIEVEMENTS

- Awards: Eagle Scout Award, and United States Army Reserve Scholar Athlete Award 2016
- Interests: Disc golf, Running, Soccer, Camping, Hiking, and Ping Pong

CHRISTIAN BAEZ

Phone: (803) 269-4614 Email: chrisbaez577@gmail.com Address: 1087 Eastgate Dr. Provo, Ut 84606

Christian is from South Carolina and is currently enrolled at BYU as a civil engineering undergraduate student. He is a graduating senior and is expected to graduate April 2021. Things that he enjoys doing are many types of sports, eating good food, and watching family shows like Lego Batman.

Education:

GPA: 3.59

Graduation Date: April 2021

Applicable Fluid Related Classes:
• Hydraulics and Fluid Flow Theory
• Hydraulic Engineering (currently taking)
• Hydrology

Job Experience:

Fluid Mechanics Teaching Assistant: 09/2021 - present
• Helps students gain a better foundational understanding of the properties of fluids in static and dynamic applications.
•Guides them through hands-on labs to reinforce learning in the classroom.

Student Engineer at Acute Engineering: 03/2021 - 09/2021
• Worked in a team of engineers to provide structural engineering for residential homes and multiplexes for two construction clients.
•Gained Experience in building codes and the relationship between clients, city governments, and engineering firms.

Full-time representative of The Church of Jesus Christ of Latter-Day Saints: 2015-2017
•Learned a new language (Brazilian Portuguese) to serve those around him.
•Worked in teams of two and three daily and adapted to the Brazilian culture.

Other Skills and Qualities

Work well with others and enjoy working in a team environment
Self-Motivated and Detail oriented
• I was complimented by other engineers and student engineers for the notes I left for the engineering checkers and my thoroughness in completing assignments at Acute Engineering.

Sheridan Hancock

(702) 477-5822 · sheridanrhancock@gmail.com · www.linkedin.com/in/sheridan-hancock

EDUCATION

Brigham Young University (BYU) — **Graduating** Apr 2022

Bachelor's Degree, Civil Engineering — *Provo, UT*

- GPA 3.92
- BYU Heritage Scholarship Recipient
- BYU ASCE Student Chapter Officer
- Research Assistant Working in Surface Water and Dam Safety
- Relevant Coursework: Drafting, Excel, Fluid Mechanics, Soil Mechanics, Environmental Engineering
- Passed FE Civil August 2021
- Spanish Fluency (reading, writing, speaking)

PROFESSIONAL EXPERIENCE

LEI Consulting Engineers and Surveyors, Inc. — Apr 2020-Present

Civil Engineering Intern — *Spanish Fork, UT*

- Storm Drain
  - Sizes storm drain retention/detention systems for projects ranging from 1-1,800 acres
  - Succeeds in sizing both surface and underground storm systems such as ponds, sumps, StormTech chambers, Contech pipes, and R-tanks with LID considerations
  - Sizes pipes and inlets for projects ranging from 1-50 acres
  - Utilizes computer programs such as Civil 3D, Storm and Sanitary Analysis (SSA), WaterCAD, and Hydraflow to solve storm drain problems
  - Compiles professional drainage reports for project submittals
- Grading plans
  - Grades site plans for projects ranging from 0-13 acres
  - Project experience includes house lots, parking lots, and townhome communities
- SWPPP
  - Prepares SWPPP documents to submit with site projects
- Plan Set Review
  - Meticulously reviews plan sets to prepare for preliminary and final submittals
  - Ensures that all plan sets are error free and meet company standards of professionalism and competency

Provo Missionary Training Center — Oct 2019-Apr 2020

Spanish Tutor — *Provo, UT*

- Worked individually with 10-15 students to assess language proficiency
- Explained in detail complex grammar topics in foreign language
- Coordinated weekly schedules between coworkers and students

Aspen Grove Family Camp — May 2019-Sept 2019

Program Counselor — *Provo, UT*

- Organized and managed groups of 15-20 guests
- Connected with guests personally and maintained high energy and enthusiasm
- Created a flexible daily schedule

The Church of Jesus Christ of Latter-Day Saints — May 2017-Nov 2018

Full-Time Volunteer Representative — *Seattle, WA*

- Studied and improved communication skills to share a cause in which I believe
- Worked intimately with people from different cultures and backgrounds
- Analyzed performance markers and set goals to improve effectiveness of performance

Appendix B

Structural Drawings

STRUCTURAL DRAWINGS

SHEET LIST

DISCLAIMER

THESE PLANS HAVE NOT BEEN REVIEWED AND CERTIFIED BY A PROFESSIONAL ENGINEER. THESE PLANS SHOULD NOT BE USED WITHOUT CERTIFICATION FROM A PROFESSIONAL ENGINEER AND ADDITIONAL CORDINATION WITH THE ARCHITECT.

THESE DRAWINGS WERE PREPARED TO PROVIDE DESIGN SPECIFICATIONS FOR A PROPOSED SIX STORY CONCRETE HOTEL. THIS PROJECT IS ALSO IN ACCORDANCE WITH A CAPSTONE PROJECT AT BRIGHAM YOUNG UNIVERSITY. THE DESIGN TEAM ARE ALL MEMBERS OF THE CABSTONE GROUP. THESE DRAWINGS WERE CREATED WITH SUPPORT FROM OUR PROJECT SPONSOR AND ADVISOR DR. TAYLOR SORENSEN WHO IS A PROFESSOR AT BRIGHAM YOUNG UNIVERSITY.

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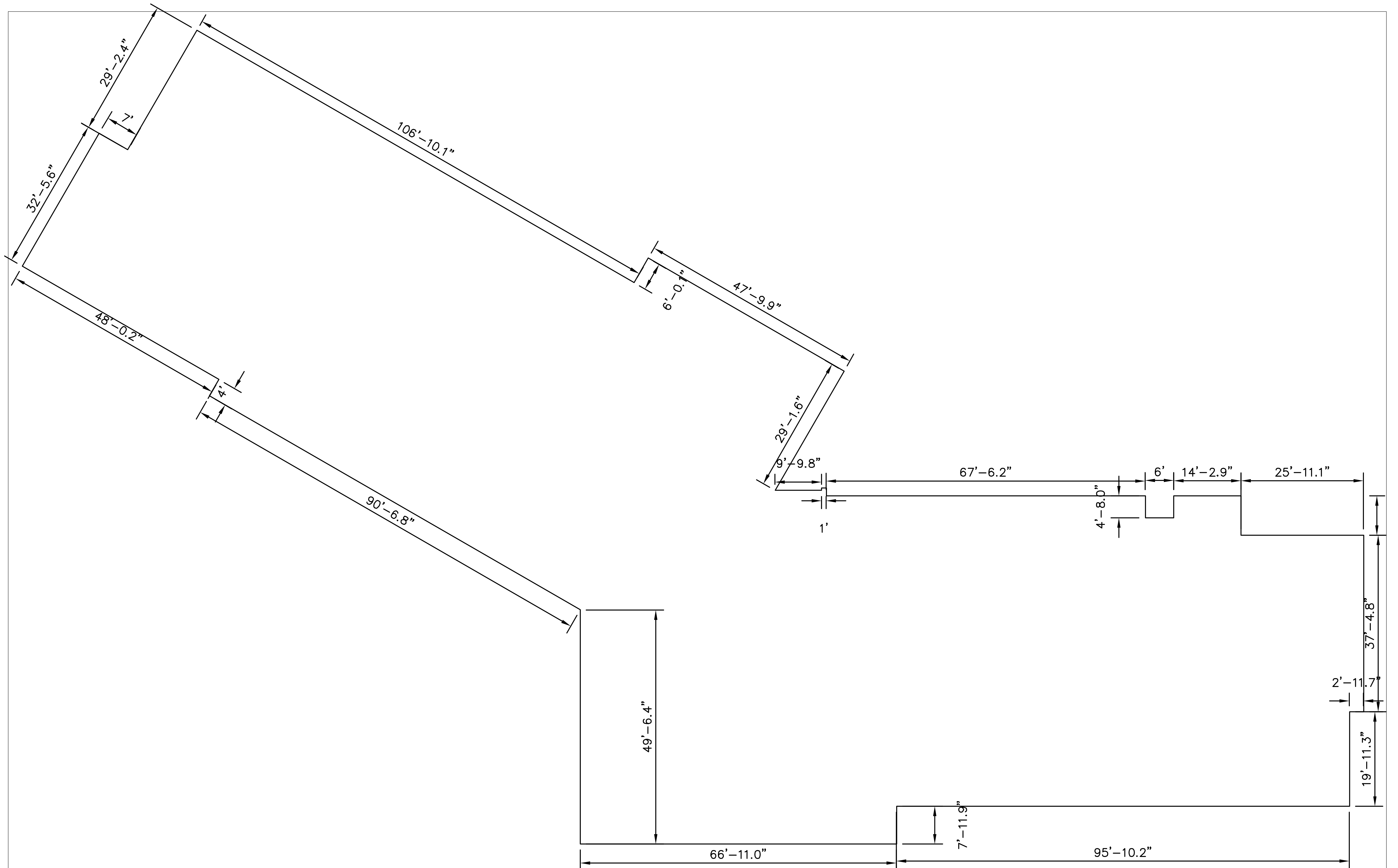


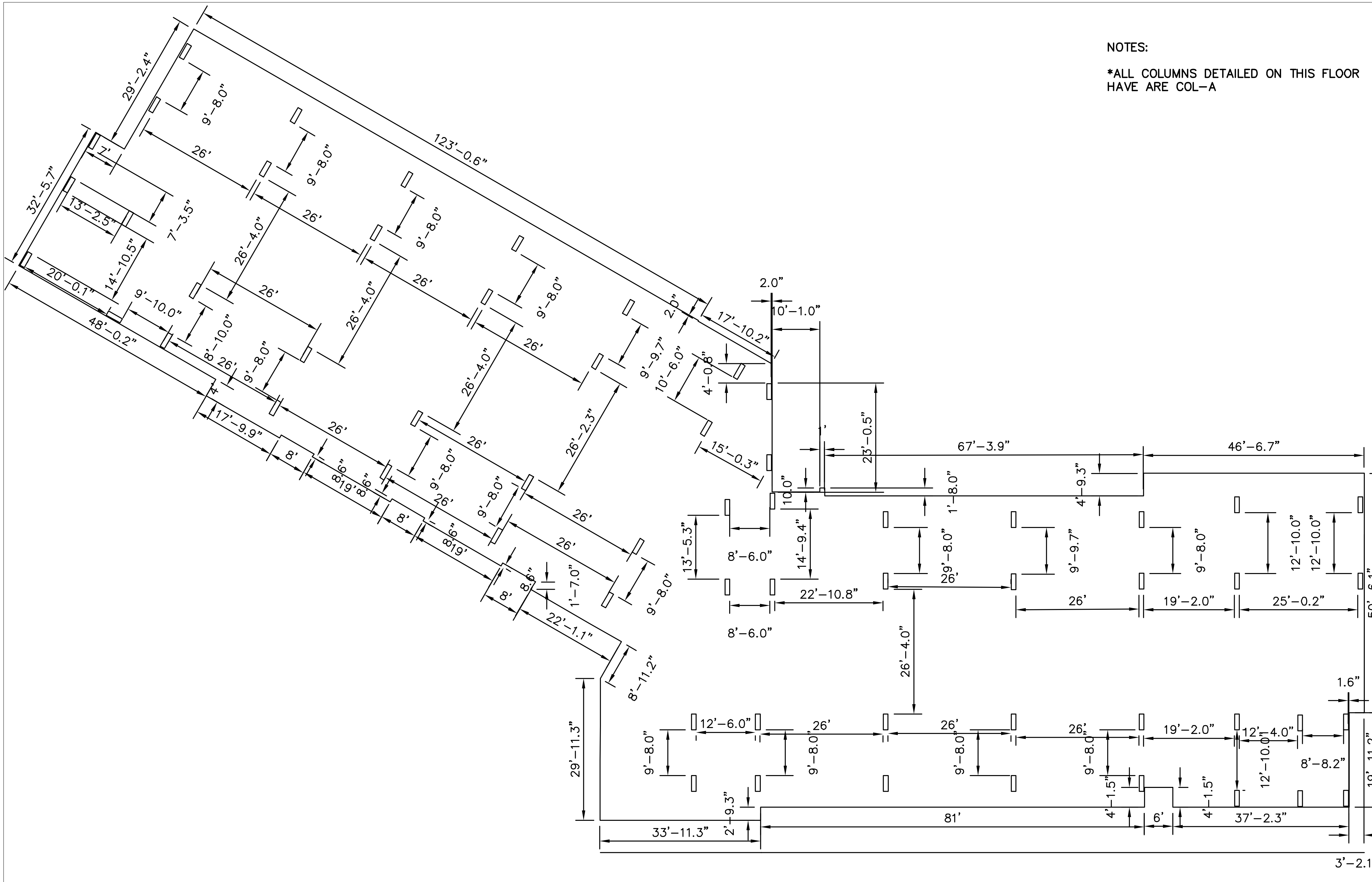
ROOF SLAB

SCALE

1"=250"

PAGE

A1



NOTES:

*ALL COLUMNS DETAILED ON THIS FLOOR HAVE ARE COL–A

cABs

6TH FLOOR SLAB AND COLUMNS

SCALE

1"=250"

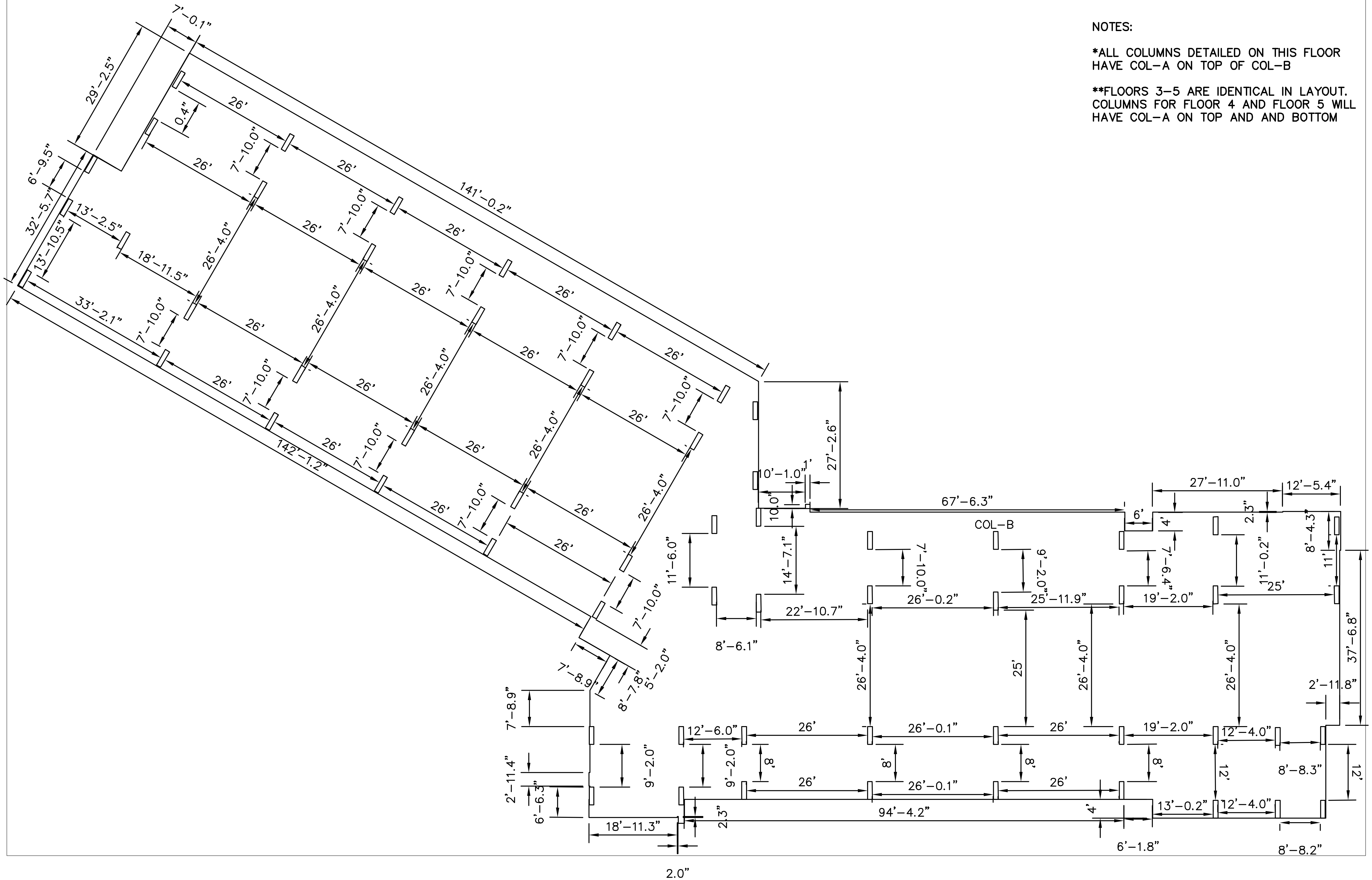
PAGE

A2

NOTES:

*ALL COLUMNS DETAILED ON THIS FLOOR HAVE COL–A ON TOP OF COL–B

**FLOORS 3–5 ARE IDENTICAL IN LAYOUT. COLUMNS FOR FLOOR 4 AND FLOOR 5 WILL HAVE COL–A ON TOP AND BOTTOM



cABs

3RD FLOOR SLAB AND COLUMNS

SCALE

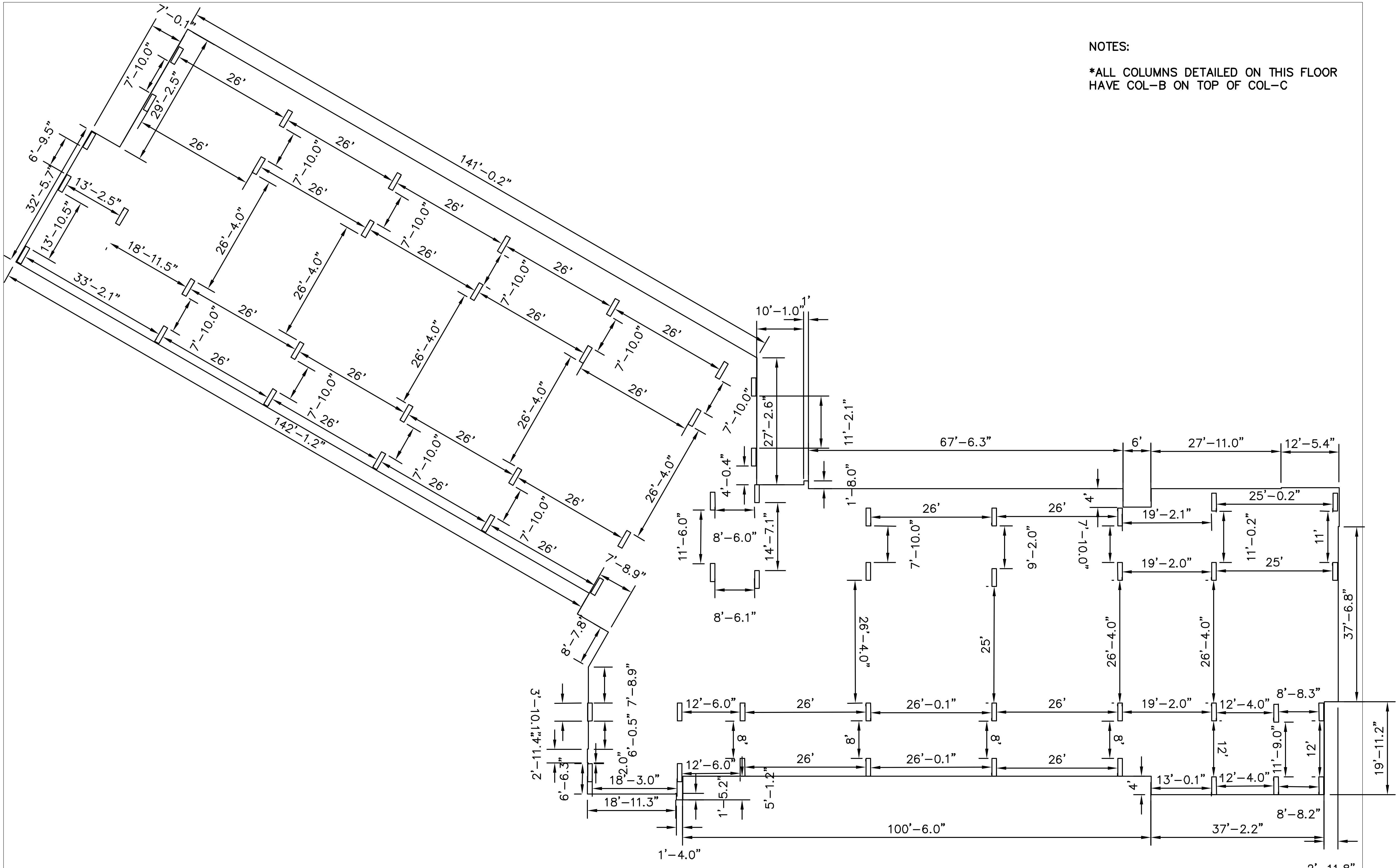
1"=250"

PAGE

A3

NOTES:

*ALL COLUMNS DETAILED ON THIS FLOOR HAVE COL-B ON TOP OF COL-C



cABs

2ND FLOOR SLAB AND COLUMNS

SCALE

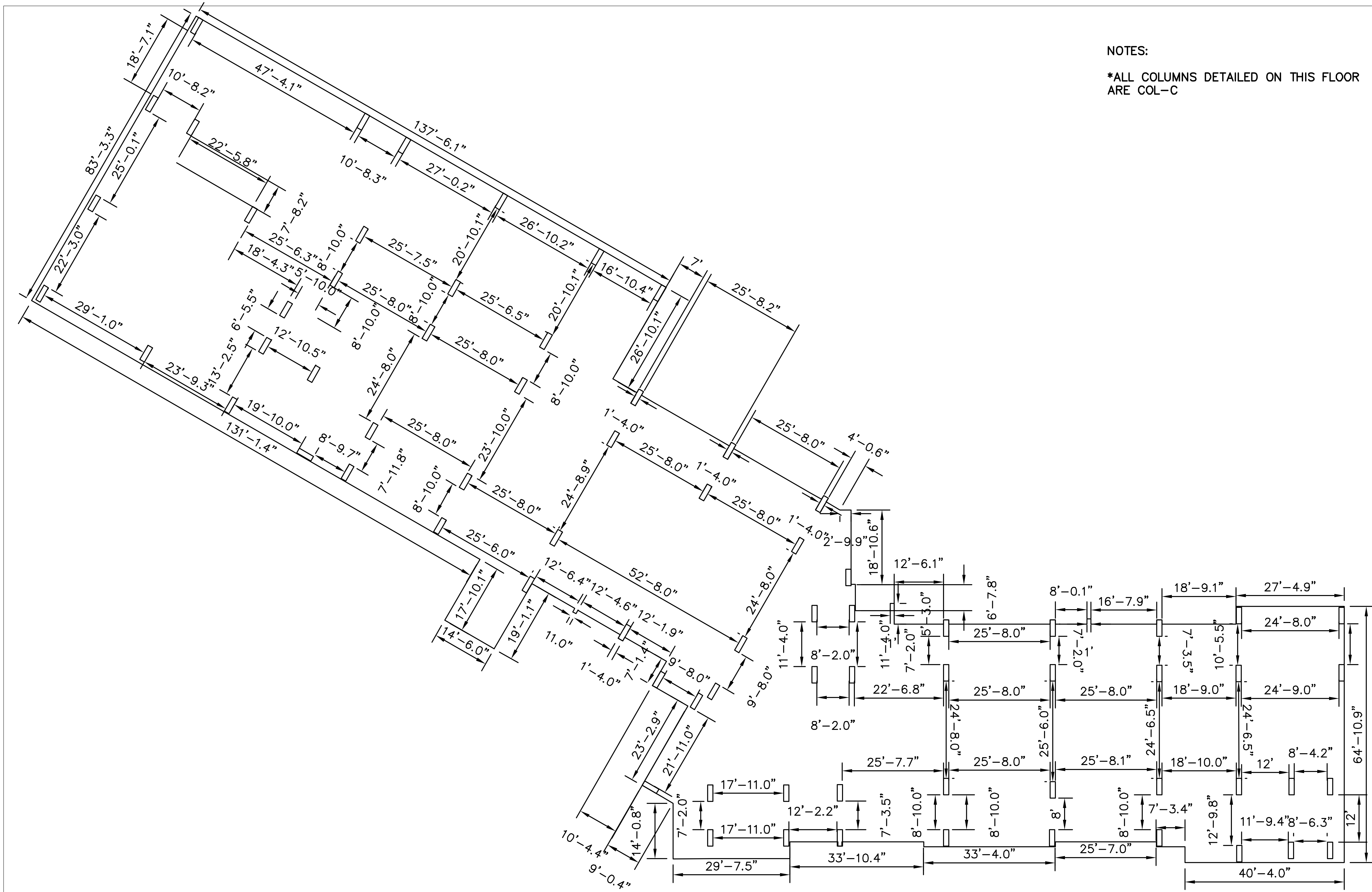
1"=250"

PAGE

A4

NOTES:

*ALL COLUMNS DETAILED ON THIS FLOOR ARE COL-C



GROUND FLOOR SLAB AND COLUMNS

cABs

SCALE

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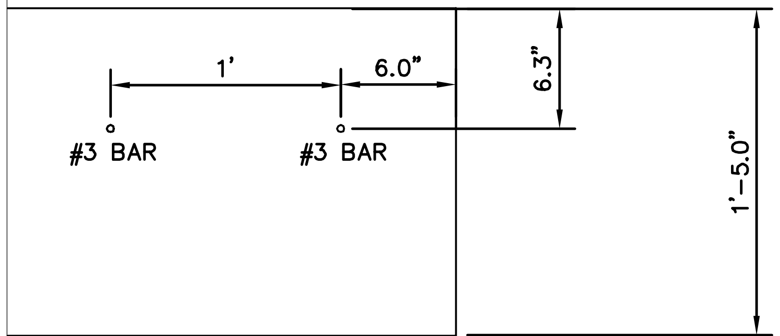
PAGE

A5

SLB-A LONGITUDINAL STEEL



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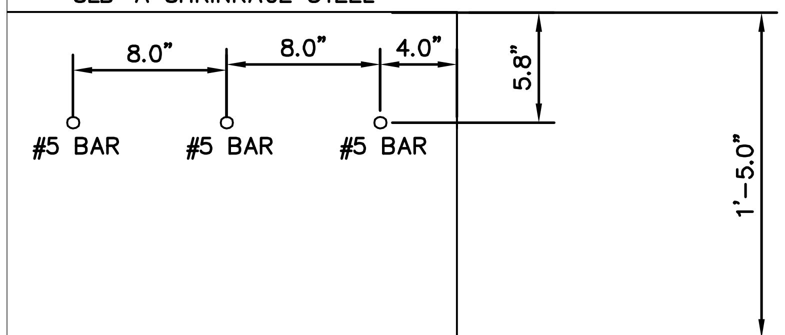
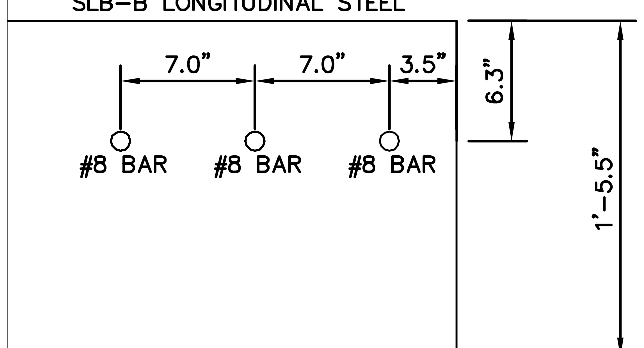
SLB-A SHRINKAGE STEEL



SCALE 1"=10"

SLB-B LONGITUDINAL STEEL



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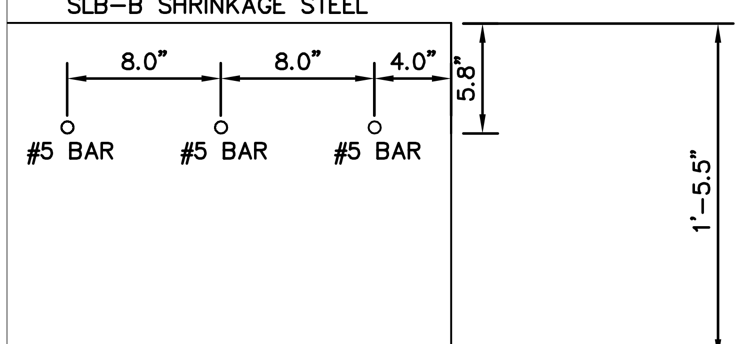
SLB-B SHRINKAGE STEEL



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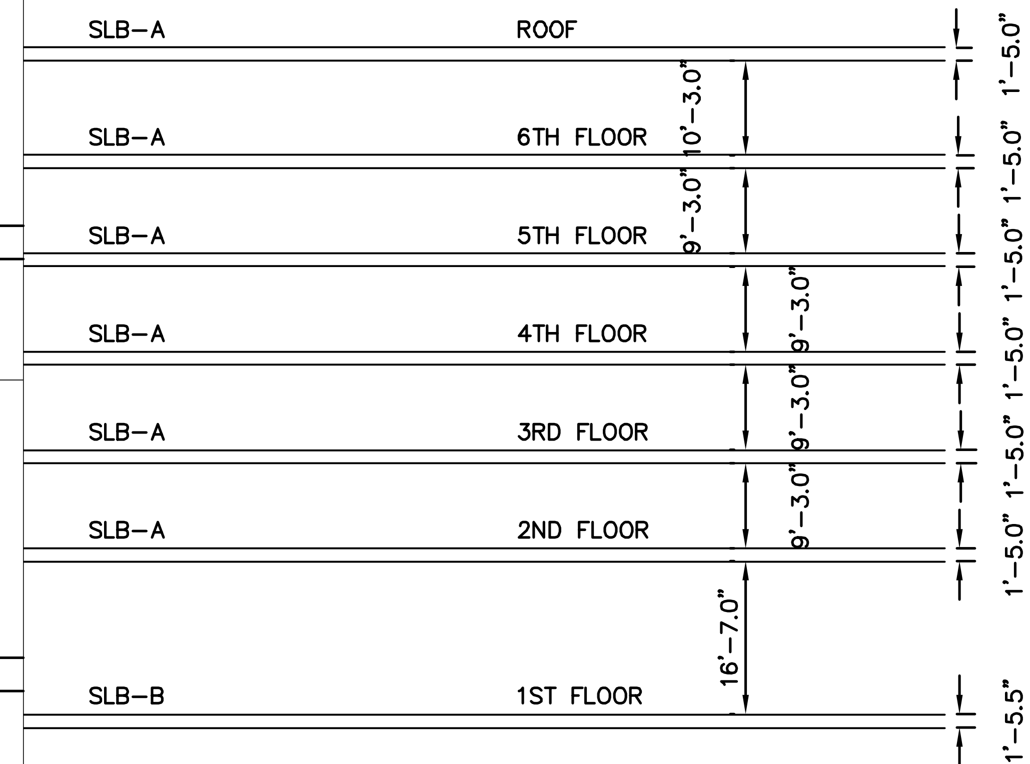


SCALE 1"=250"

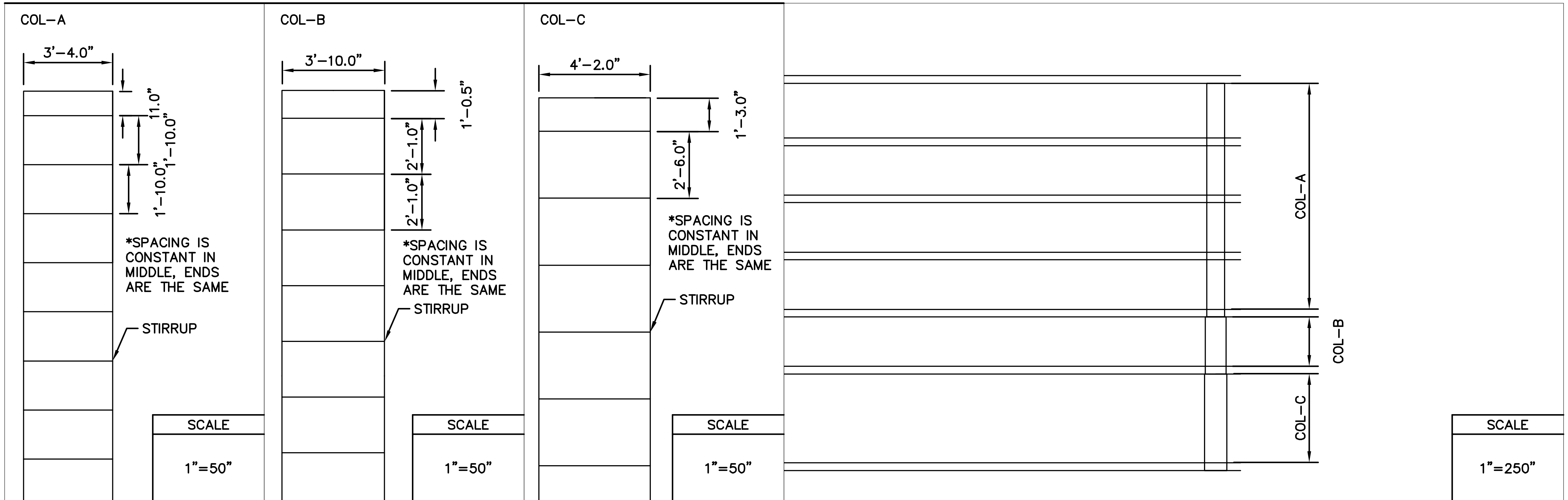
FOR SLB-A AND SLB-B

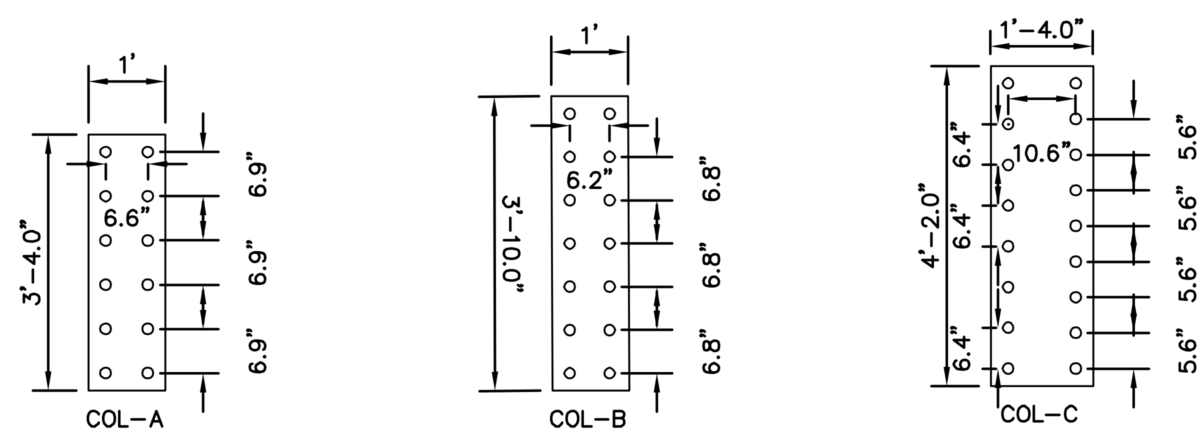
CONCRETE SPECIFICATIONS:
COMPRESSIVE CONCRETE STRENGTH: 4 KSI

REINFORCING STEEL SPECIFICATIONS:
GRADE 60 STEEL

SLAB DETAILS

PAGE B1





COLUMN DETAILS:
WIDTH–12"

CONCRETE:
COMPRESSIVE
STRENGTH–6 KSI

REINFORCEMENT
STEEL:
GRADE 80
#14 BARS
#4 STIRRUPS

COLUMN DETAILS:
WIDTH–12"

CONCRETE:
COMPRESSIVE
STRENGTH–6 KSI

REINFORCEMENT
STEEL:
GRADE 80
#14 BARS
#4 STIRRUPS

COLUMN DETAILS:
WIDTH–16"

CONCRETE:
COMPRESSIVE
STRENGTH–6 KSI

REINFORCEMENT
STEEL:
GRADE 80
#14 BARS
#4 STIRRUPS

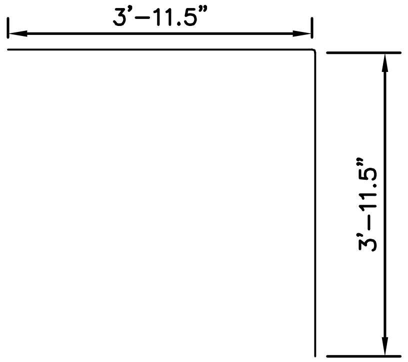
SCALE
1"=30"

COLUMN DETAILS

PAGE

B2

#8 BAR DEVELOPMENT LENGTH

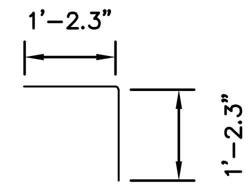


GRADE 60
STEEL

CONCRETE
COMPRESSIVE
STRENGTH
4KSI

SCALE
1"=30"

#3 BAR DEVELOPMENT LENGTH

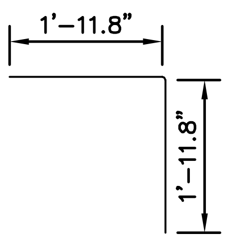


GRADE 60
STEEL

CONCRETE
COMPRESSIVE
STRENGTH
4KSI

SCALE
1"=30"

#5 BAR DEVELOPMENT LENGTH

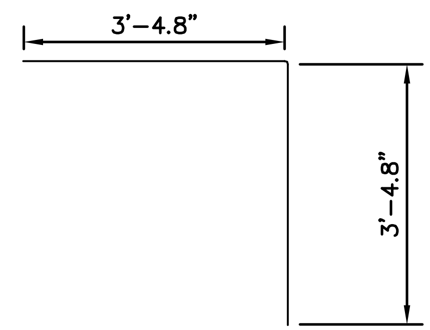


GRADE 60
STEEL

CONCRETE
COMPRESSIVE
STRENGTH
4KSI

SCALE
1"=30"

#14 BAR DEVELOPMENT LENGTH

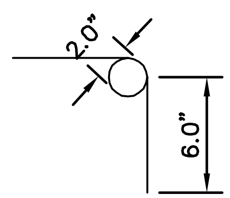


GRADE 80
STEEL

CONCRETE
COMPRESSIVE
STRENGTH
6KSI

SCALE
1"=30"

#4 STIRRUP DEVELOPMENT LENGTH



GRADE 80
STEEL

CONCRETE
COMPRESSIVE
STRENGTH
6KSI

SCALE
1"=10"

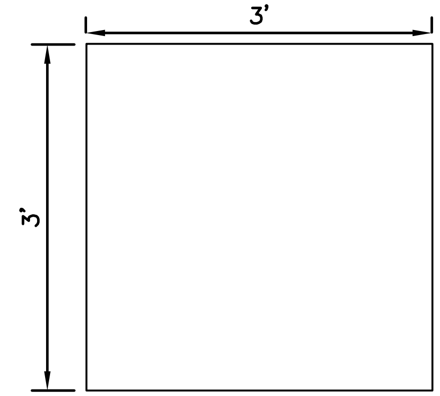
cABs

CONNECTION DETAILS

PAGE
B3

PIER CAP TOP VIEW

COMPRESSIVE CONCRETE STRENGTH 6 KSI

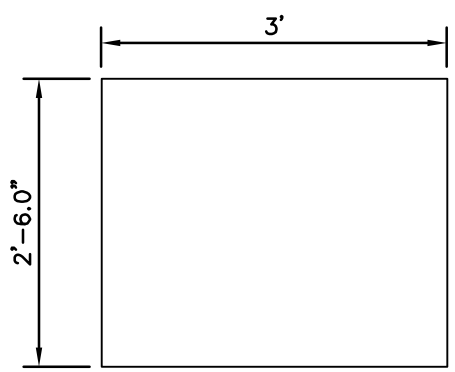


SCALE

1"=20'

PIER CAP SIDE VIEW

COMPRESSIVE CONCRETE STRENGTH 6 KSI



SCALE

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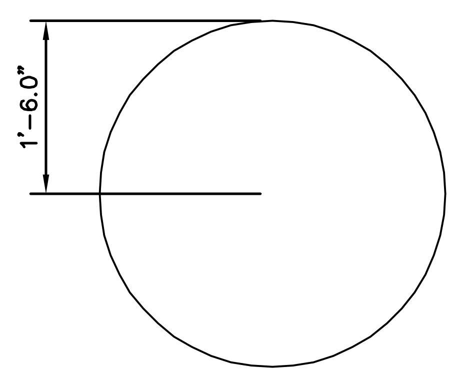
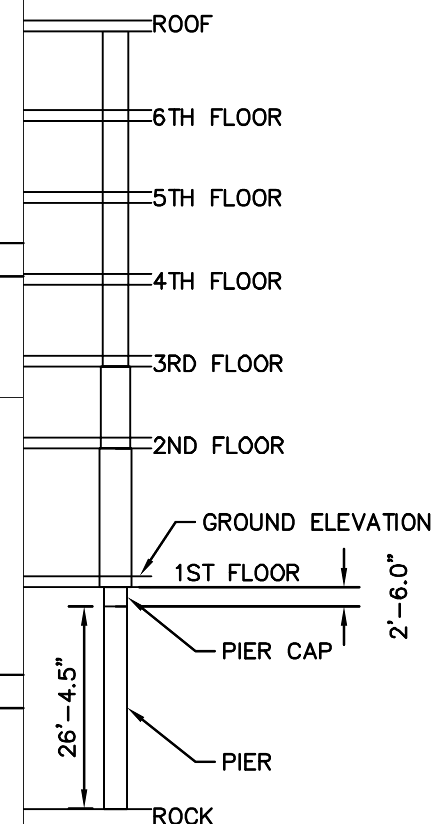
PIER TOP VIEW

COMPRESSIVE CONCRETE STRENGTH 6 KSI



SCALE

1"=20"

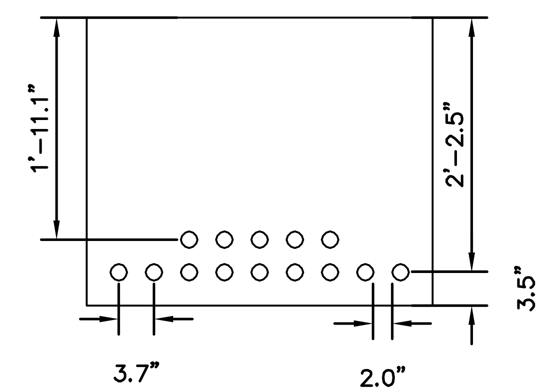


SCALE

1"=300"

PIER CAP SIDE VIEW WITH REINFORCEMENT

#14 BARS USED
GRADE 60 STEEL



SCALE

1"=20"

FOUNDATION DETAILS

PAGE

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Appendix C

Calculations

Calculations Appendix

Table of Contents

Column Design Methodology

Variables:

P = factored load
f'c = concrete strength
fy = f1 = f2= strength of steel
b = width of the column
h = height of the column
At = total area of steel reinforcement
Ag = gross area of concrete
n= number of reinforcement bars
db = diameter of reinforcement bars
ds = diameter of stirrups
dc = clear distance
d= depth to steel to centroid of steel

ɣx = $(b - 2 * d_c)/b$ (used a clear distance of 2.5 inches)
ɣy = $(h - 2 * d_c)/h$ (used a clear distance of 2.5 inches)
ex = ey = constant value we assumed since we were not considering the lateral load.
ρg = At/Ag

From this point, interaction diagrams were used to obtain the Kn values for the x and y direction. With this value the Pn in both directions was calculated.

$$P_{nx} = K_{nx} * f'_c * Ag$$

$$P_{no} = 0.85 * f'_n * Ag + f_y * At$$

$$P_n = 1/(1/P_{ny} + 1/P_{nx} + 1/P_{no})$$

$$\phi = 0.65$$

We want $\phi P_n > P$

Spacing: $s = h - d_b * n/2 - d_b * (n/2 - 1) - d_c - 2 * d_s$

Column Shear

$$d = h - d_c - d_s - d_b$$

Check: $Nu/(6 * Ag) < 0.05 * f'c$

$$V_c = (2 * \lambda * \sqrt{f'_c} + Nu/(6 * Ag)) * b * d$$

$$\phi = 0.75$$

Check: $\phi V_c < 5 * \lambda * \sqrt{f'_c} * b * d$

$$\phi V_S = V_u - \phi V_c$$

Check: $\phi V_s < 8 * \lambda * \sqrt{f'_c} * b * d$

Check: if $0.5 * \phi V_c > V_u$ then no stirrups are required.

We assumed a Vu of 80 kips since we did not do the lateral forces. None of the columns required the stirrups. So, we spaced them at 12 inch on center

Additional Variables

L = length of the slab
Mu = ultimate moment
εy = yield strain of steel
s= spacing of bars

Column Design Calculations

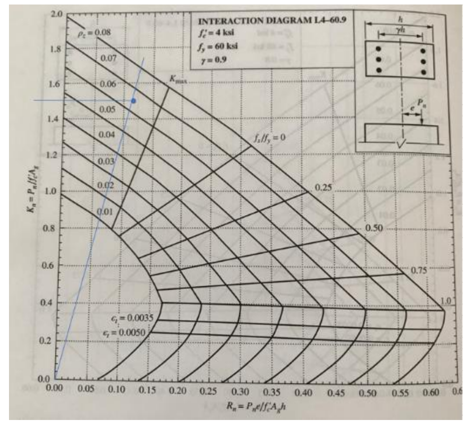
Roof to Third Floor Columns (COL-A)

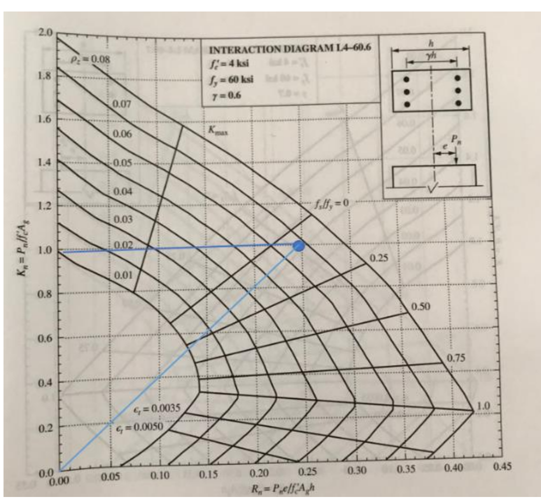
Design

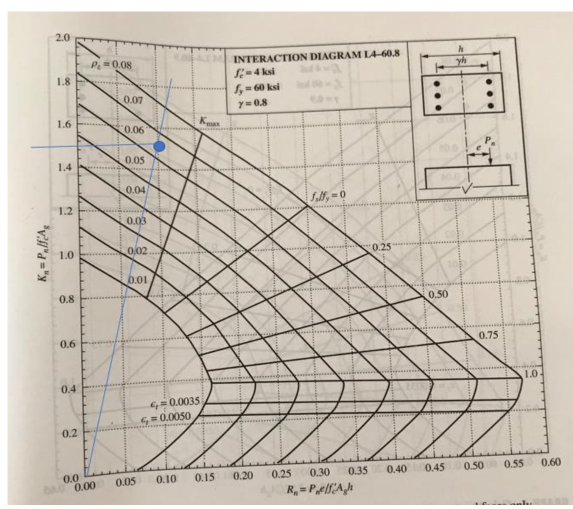
Load	742	kips	
Live Load, Pl		kips	
f'c	6	ksi	
fy=fs1=fs2	80	ksi	
Rein. Bars	14		
Area	2.75	in^2	
# of bars	12		
Area total	33	in^2	
# of bars right side	3		
Area right side	8.25	in^2	
b (x)	12	in	
h (y)	40	in	
gamma y direction	0.5833		
gamma x direction	0.875		slopes
ex	3		0.075
ey	3		0.25
ρg	0.0688		
Lower Gamma y	0.5		
Higher Gamma y	0.6		
Fraction between	0.8333		
kn y 1	1		
kn y 2	1		
ACTUAL kn y	1		
Pny	2880	kips	
Lower Gamma x	0.8		
Higher Gamma x	0.9		
Fraction between	0.75		
kn x 1	1.5		
kn x 2	1.5		
ACTUAL kn x	1.5		
Pnx	4320	kips	
Pno	5088	kips	
Pn	1289.9	kips	
φ	0.65		
φ Pn	838.45	kips	Pass
Pu	742	kips	
spacing	22.373	in	Pass
spacing	30.838	in	Pass

Shear

Pu	779.3	kips	
Vu	80	kips	
Nu=Pu	779.3	Kips	
b	12	in	
h	40	in	
Stirrup bar size	3		
diameter	0.375	in	
Reinforcement si	14		
Diameter	1.693	in	
d	37.279	in	
Nu/(6*Ag)	0.2706	ksi	
f'c	6	ksi	
Check One	0.3	ksi	Pass
λ	1		
Vc	190.35	kips	
φ	0.75	kips	
φVc	142.76	kips	
Check φVc	173.25	kips	Pass
φVs	-62.76	kips	
Check φVs	277.21	Kips	Pass
Stirrups Bar Size	3		
Area of Bar	0.7	in^2	
fy	60	ksi	
Sreq (min)	-37.42	in	
Check for req stirr	71.381	kips	Stirrups required everywhere
Check Av min 1	0.0116	in	
Check Av min 2	0.01	in	
Max Av min	0.0116	in	
Sv req	120.49	in	
Smax threshold c	138.6	kips	ok
S max check 1	18.639	in	
S max check 2	24	in	
Smax used	18.639	in	







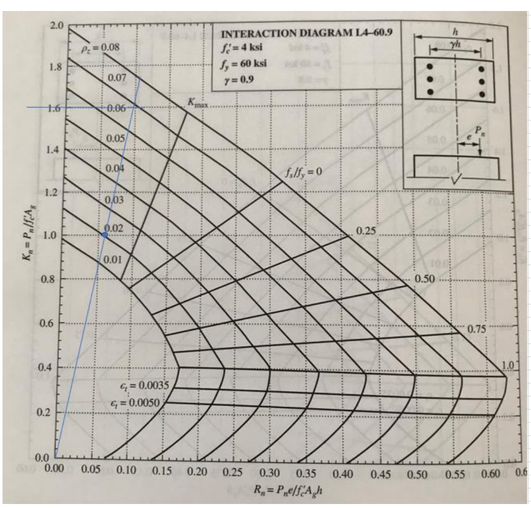
Third Floor to Second Floor (COL-B)

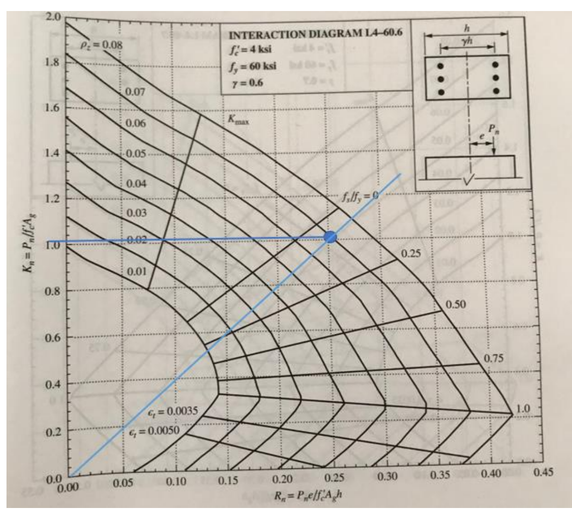
Design

Load	970.3	kips	
Live Load, Pl		kips	
f'c	6	ksi	
fy=fs1=fs2	80	ksi	
Rein. Bars	14		
Area	2.75	in^2	
# of bars	14		
Area total	38.5	in^2	
# of bars right side	3		
Area right side	8.25	in^2	
b (x)	12	in	
h (y)	46	in	
gamma y direction	0.5833		
gamma x direction	0.8913		slopes
ex	3		0.0652
ey	3		0.25
ρg	0.0697		
Lower Gamma y	0.5		
Higher Gamma y	0.6		
Fraction between	0.8333		
kn y 1	1		
kn y 2	1		
ACTUAL kn y	1		
Pny	3312	kips	
Lower Gamma x	0.8		
Higher Gamma x	0.9		
Fraction between	0.913		
kn x 1	1.6		
kn x 2	1.6		
ACTUAL kn x	1.6		
Pnx	5299.2	kips	
Pno	5895.2	kips	
Pn	1514.5	kips	
φ	0.65		
φ Pn	984.45	kips	Pass
Pu	970.3	kips	
spacing	25.759	in	Pass
spacing	25.759	in	Pass

Shear

Pu	970.3	kips	
Vu	80	kips	
Nu=Pu	970.3	Kips	
b	12	in	
h	46	in	
Stirrup bar size	3		
diameter	0.375	in	
Reinforcement siz	14		
Diameter	1.693	in	
d	43.279	in	
Nu/(6*Ag)	0.293	ksi	
f'c	6	ksi	
Check One	0.3	ksi	Pass
λ	1		
Vc	232.61	kips	
φ	0.75	kips	
φVc	174.45	kips	
Check φVc	201.14	kips	Pass
φVs	-94.45	kips	
Check φVs	321.82	Kips	Pass
Stirrups Bar Size	3		
Area of Bar	0.11	in^2	
fy	60	ksi	
Sreq (min)	-4.536	in	
Check for req stirr	87.227	kips	Not Required
Check Av min 1	0.0116	in	
Check Av min 2	0.01	in	
Max Av min	0.0116	in	
Sv req	18.935	in	
Smax threshold c	160.91	kips	ok
S max check 1	21.639	in	
S max check 2	24	in	
Smax used	21.639	in	





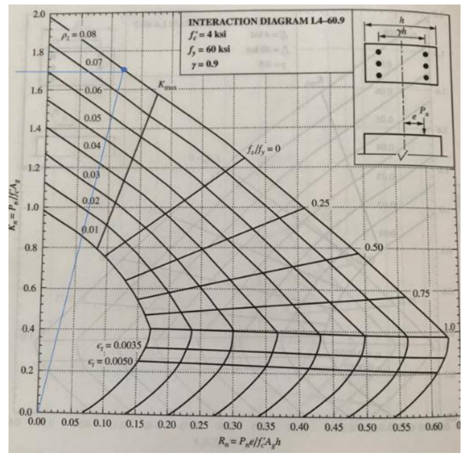
Second Floor to First Floor

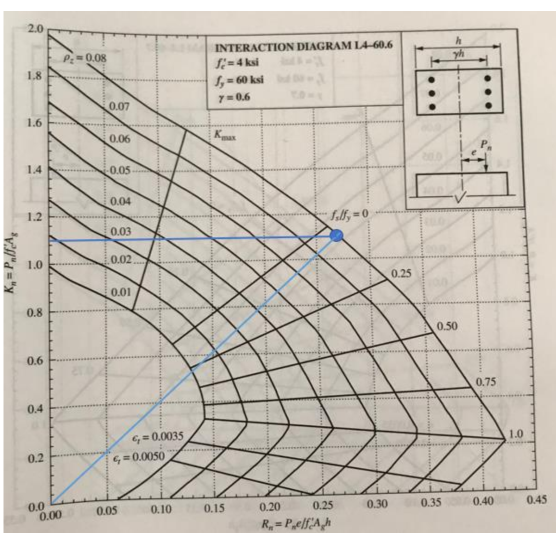
Design

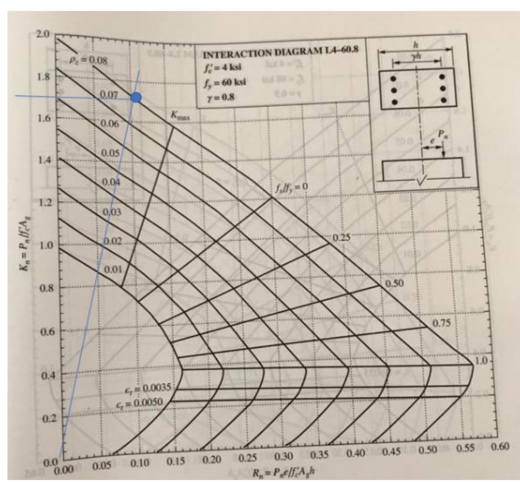
Load	1161.5	kips	
Live Load, Pl		kips	
f'c	7	ksi	
fy=fs1=fs2	80	ksi	
Rein. Bars	14		
Area	2.75	in^2	
# of bars	17		
Area total	46.75	in^2	
# of bars right side	3		
Area right side	8.25	in^2	
b (x)	12	in	
h (y)	50	in	
gamma y directior	0.5833		
gamma x directior	0.9		slopes
ex	3		0.06
ey	3		0.25
ρg	0.0779		
Lower Gamma y	0.5		
Higher Gamma y	0.6		
Fraction between	0.8333		
kn y 1	1.2		
kn y 2	1.2		
ACTUAL kn y	1.2		
Pny	5040	kips	
Lower Gamma x	0.9		
Higher Gamma x	0.9		
Fraction between	0		
kn x 1	1.7		
kn x 2	1.7		
ACTUAL kn x	1.7		
Pnx	7140	kips	
Pno	7310	kips	
Pn	2104.1	kips	
φ	0.65		
φ Pn	1367.7	kips	Pass
Pu	1161.5	kips	
spacing	30.838	in	Pass

Shear

Pu	1161	kips	
Vu	80	kips	
Nu=Pu	1161	Kips	
b	12	in	
h	50	in	
Stirrup bar size	3		
diameter	0.375	in	
Reinforcement siz	14		
Diameter	1.693	in	
d	47.279	in	
Nu/(6*Ag)	0.3225	ksi	
f'c	7	ksi	
Check One	0.35	ksi	Pass
λ	1		
Vc	277.9	kips	
φ	0.75	kips	
φVc	208.43	kips	
Check φVc	237.34	kips	Pass
φVs	-128.4	kips	
Check φVs	379.74	Kips	Pass
Stirrups Bar Size	3		
Area of Bar	0.11	in^2	
fy	60	ksi	
Sreq (min)	-3.645	in	
Check for req stirr	104.21	kips	Not Required
Check Av min 1	0.0125	in	
Check Av min 2	0.01	in	
Max Av min	0.0125	in	
Sv req	17.53	in	
Smax threshold c	189.87	kips	ok
S max check 1	23.639	in	
S max check 2	24	in	
Smax used	23.639	in	







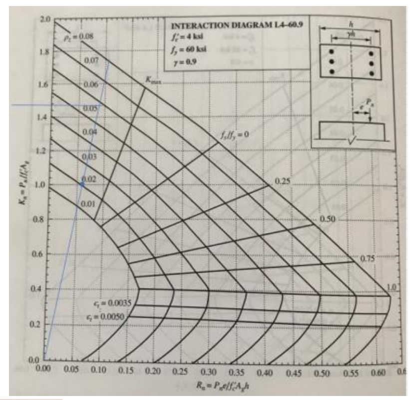
Second to First Floor Type 2 (COL-C)

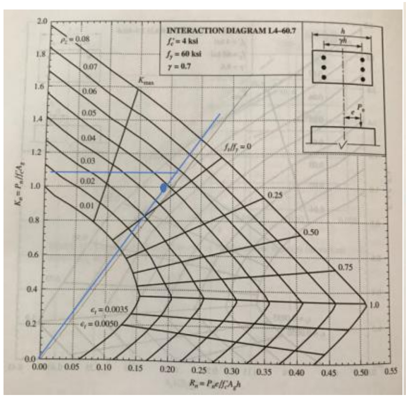
Design

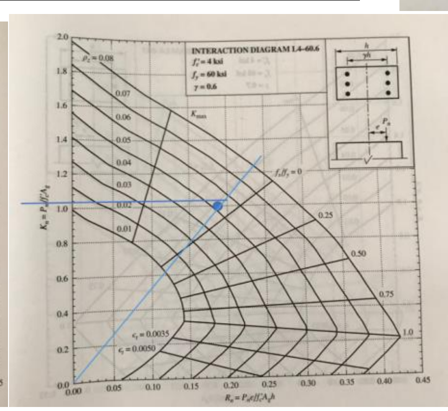
Load	1161.5	kips	
Live Load, Pl		kips	
f'c	6	ksi	
fy=fs1=fs2	80	ksi	
Rein. Bars	14		
Area	2.75	in^2	
# of bars	17		
Area total	46.75	in^2	
# of bars right side	3		
Area right side	8.25	in^2	
b (x)	16	in	
h (y)	50	in	
gamma y direction	0.6875		
gamma x direction	0.9		slopes
ex	3		0.06
ey	3		0.1875
ρg	0.0584		
Lower Gamma y	0.6		
Higher Gamma y	0.7		
Fraction between y	0.875		
kn y 1	1.04		
kn y 2	1.08		
ACTUAL kn y	1.075		
Pny	5160	kips	
Lower Gamma x	0.9		
Higher Gamma x	0.9		
Fraction between x	0		
kn x 1	1.48		
kn x 2	1.48		
ACTUAL kn x	1.48		
Pnx	7104	kips	
Pno	7820	kips	
Pn	2162.4	kips	
φ	0.65		
φ Pn	1405.6	kips	Pass
Pu	1161.5	kips	
spacing	30.838	in	Pass

Shear

Pu	1161.5	kips	
Vu	80	kips	
Nu=Pu	1161.5	Kips	
b	16	in	
h	50	in	
Stirrup bar size	3		
diameter	0.375	in	
Reinforcement size	14		
Diameter	1.693	in	
d	47.279	in	
Nu/(6*Ag)	0.242	ksi	
f'c	7	ksi	
Check One	0.35	ksi	Pass
λ	1		
Vc	309.63	kips	
φ	0.75	kips	
φVc	232.22	kips	
Check φVc	316.45	kips	Pass
φVs	-152.2	kips	
Check φVs	506.32	Kips	Pass
Stirrups Bar Size	4		
Area of Bar	0.7	in^2	
fy	60	ksi	
Sreq (min)	-19.57	in	
Check for req stirrup	116.11	kips	Not Required
Check Av min 1	0.0167	in	
Check Av min 2	0.0133	in	
Max Av min	0.0167	in	
Sv req	83.666	in	
Smax threshold che	253.16	kips	ok
S max check 1	23.639	in	
S max check 2	24	in	
Smax used	23.639	in	







Slab Design Methodology

Longitudinal Bars

Check minimum h: $h_{min} = L/20\ IN\ INCHES$

$$\beta = 0.85$$

$$\rho = 0.5 * (0.85 * \beta * f'_c/f_y * \varepsilon_y)$$

$$\phi = 0.90$$

$$d_{req} = \sqrt{M_u/(\rho * \phi * b * f'_y * (1 - \rho * f_y/(1.7 * f'_c)))}$$

$$\rho_{req} = 0.85 * f'_c/f_y * (1 - \sqrt{1 - 2 * (M_u/(\phi * b * d^2))/(0.85 * f'_c)}\ )$$

$$A_s = d * b * \rho_{req}$$

Check Spacing: $A_b * 12/s > A_s$

Shrinkage Steel

$$A_s = 0.0018 * b * h$$

Check Spacing: $A_b * 12/s > A_s$

Slab Design Calculations

Roof through 2nd Floor (SLB-A)

Slabs			
f'c	4	ksi	
fy	60	ksi	
length	28.33	ft	
h min	16.998	in	
h	17	in	
b	12	in	
Mu	2.9525	k*in	
β	0.85		
ρ	0.0143		
φ	0.9		
d required	0.6047	in	
d used	6.25	in	
ρ required	0.0001		
As requirec	0.0088	in^2/ft	
Bar size	3		
Area of Ba	0.11	in^2	
Sapcing	1	in	
Check	1.32	in^2/ft	Pass
Shrinkage Steel			
As	0.3672	in^2	
Bar size	5		
Area of Ba	0.31	in^2	
Sapcing	8	in	
Check	0.465	in^2/ft	Pass

First Floor Slab (SLB-B)

Slabs			
f'c	4	ksi	
fy	60	ksi	
length	29	ft	
h min	17.4	in	
h	17.5	in	
b	12	in	
Mu	351.13	k*in	
β	0.85		
ρ	0.01425		
φ	0.9		
d required	6.59437	in	
d used	6.25	in	
ρ required	0.01618		
As required	1.21368	in^2/ft	
Bar size	8		
Area of Bar	0.79	in^2	
Sapcing	7	in	
Check	1.35429	in^2/ft	Pass
Shrinkage Steel			
As	0.378	in^2	
Bar size	5		
Area of Bar	0.31	in^2	
Sapcing	8	in	
Check	0.465	in^2/ft	Pass

Pile Cap Design Methodology

Variables

$q_a = allowable\ soil\ pressure$
$q_u =\ ultimate\ bearing\ pressure$
$A_{min} =\ minimum\ area\ of\ footing$
$b_{min} =\ minimum\ side\ dimension\ assuming\ a\ square\ cap$
$l_l =\ long\ column\ dimension$
$l_s =\ short\ column\ dimension$
$A =\ area\ of\ footing/pier\ cap$
$\lambda_s = 1\ for\ foundations\ and\ \lambda\ =\ 1\ normal\ weight\ concrete$
$\phi = 0.75$
$\rho_w =\ 0.0018\ assuming\ minimum\ required$
$d_{req} = depth\ to\ centroid\ of\ the\ steel$
$d_{used} =\ actual\ used\ depth\ to\ centroid\ of\ steel$
$d_{cover} =\ thickness\ of\ concrete\ to\ cover\ the\ steel\ =\ 2.5in$
$d_b =\ diameter\ of\ reinforcing\ bar$
$h_{min} =\ minimum\ thickness\ of\ the\ cap/footing$
$h_{used} =\ thickness\ used\ for\ slab$
$V_n =\ shear\ capacity$
$M_u = ultimate\ moment$
$M_n = moment\ capacity$

Method

$$A_{min} = P/q_a$$

$$b_{min} = A_{min}{}^{0.5}$$

$$A\ =\ b^2$$

$$q_u = P/A$$

$$d_{req} =\ (b - l_l)/(\phi * 16 * \rho_w{}^{1/3} * \sqrt{f'_c}/q_u + 2)$$

$$h_{min} =\ d_{cover} + d_{req} + 1.5 * d_b$$

$$d_{used}\ =\ h_{used} - d_{cover} - 1.5 * d_b$$

$$\phi V_n =\ \phi * 8 * \lambda * \lambda_s * \rho_w{}^{1/3} * \sqrt{f'_c} * l_l * d$$

$$V_{u1} =\ (b/2 - l_l/2 - d) * b * q_u$$

Check $\phi V_n > V_u$

$$v_n = v_c = min(4\lambda\lambda_s\sqrt{f'_c}\ or\ (2 + 4/\beta)\lambda\lambda_s\sqrt{f'_c}\ or\ (2 + \alpha_s d/b_0)\lambda\lambda_s\sqrt{f'_c})$$

$$\phi V_n = \phi(v_n b_0 d)$$

$$V_{u2} = q_u[b^2 - (l_l + d)^2]$$

Check: $\phi V_n > V_{u2}$

$$M_u = q_u * ((b - l_l)/2)^2 b/2$$

$$a = A_s f_y (0.85 f'_c b)$$

$$\phi_f = 0.9$$

$$M_u \leq \phi A_s f_y (d - A_s f_y / (2(0/85 f'_c b)))$$

Solve for A_s

$$c = a/\beta$$

$$\epsilon_t = \varepsilon_c (d - c)/c$$

$$W_f = b^2 h \gamma_c$$

$$W_c = {b_c}^2 (d_{foot} - h)\gamma_s$$

$$W_{total} = W_f + W_c + W_s + P$$

$$q_{gr} = W_{total}/A$$

$$q_n = q_{gr} - d_{foot}\gamma_s$$

Check $q_n < q_a$

Pile Cap Design Calculation

Footings					
P	1342.2	kips	unfactored		
qa (all. Soil pressure)	5000	psf			
Amin	268.45	ft^2			
b min	16.384	ft			
b	36	ft			
column long dimensio	56	in	factored		
column short dimensio	12	in			
Pu	1342.2	kips			
A	1296	ft^2			
qu	1.0357	ksf			
λs	1		1 for foundations		
λ	1		1 for normal weight concrete I think		
φ	0.75				
f'c	6	ksi			
ρw	0.0018		assuming minimum re		
d required	21.218	in			
d cover	3	in			
bar size	14				
diameter of bar (db)	1.693	in			
h min	26.757	in			
h used	30	in	try even sizes		
d used	24.461	in			
φVn	597.4	kips			
Vu1	508.13	kips	Pass		
vn=vc 1	309.84	psi			
vn=vc 2	221.31	psi		546670	
vn=vc 3	390.4	psi			
vn,vc used	221.31	psi			
φVn	1306.7	kips			
Vu2	1295.7	kips	Pass		
Mu	4575.7	k*ft			
fy	60	ksi			
φ	0.9				
As req	3.2575	in^2			
φMn	357.91	k*in	use goal seek to change this number to equal mu by changing as required		
As min	23.328	in^2			
Area that governs	23.328	in^2			
Bar Area	2.75	in^2			
Number of bars	14				
Total Area	38.5	in^2	Pass		
a	1.0485	in			
β	0.85				
c	1.2335	in			
et	0.0565		Pass		
Wf	486	k	gamma concr	0.15	k/ft^3
Wc	-1.05	k	depth of ft	1	ft
Ws	-193.7	k	gamma soil	0.1	fk/ft^3
Wtotal	1633.5	k			
qgr	1260.4	psf			
qn	1160.4	psf	Pass		

one way shear design in yellow

2 way in red

purple is flexure design

Foundation Design Methodology and Calculation

Diameter of the Drilled Pier

$$d_{shaft} \geq \left[\frac{4P}{\pi(0.3f'c)}\right]^{1/2}$$

d_{shaft} = diameter of the drilled pier

P = axial load

$f'c$ = compressive strength of concrete

For our project…

P = 1400500 lb

$f'c$ = 6000 psi

$$d_{shaft} \geq \left[\frac{4 * 1400500}{\pi(0.3 * 6000)}\right]^{1/2}$$

$$d_{shaft} = 31.48 \text{ in}$$

→ round to nearest 6 in

→ d_{shaft} = 36 in

Check diameter against maximum allowable load table shown below

Since 1400.5 kip<1832 kip, the diameter passes

Table 4.5 Pier maximum allowable load based on allowable concrete compression stress per 2015 IBC Table 1810.3.2.6.

Pier Diameter (ft-in.)	Pier Area (in.^{2})	PIER MAXIMUM ALLOWABLE AXIAL LOAD-KIPS* $f_c = 0.30 f'_c$			
		f'_c = 3,000 psi	f'_c = 4,000 psi	f'_c = 5,000 psi	f'_c = 6,000 psi
1-6	254	229	305	382	458
2-0	452	407	543	679	814
2-6	707	636	848	1,060	1,272
3-0	1,018	916	1,221	1,527	1,832
3-6	1,385	1,247	1,662	2,078	2,494
4-0	1,810	1,629	2,171	2,714	3,257
4-6	2,290	2,061	2,748	3,435	4,122
5-0	2,827	2,545	3,393	4,241	5,089
5-6	3,421	3,079	4,105	5,132	6,158
6-0	4,071	3,664	4,886	6,107	7,328
6-6	4,778	4,300	5,734	7,167	8,601
7-0	5,542	4,987	6,650	8,312	9,975

Development Length Design Methodology

Bars (tension)

Bar Size	L_d	Clear Space
$\leq$ #6	$= \frac{f_y \psi_t \psi_e d_b}{25\lambda\sqrt{f'_c}}$	At least d_b and $2d_b$ if splice
$\geq$ #7	$= \frac{f_y \psi_t \psi_e d_b}{20\lambda\sqrt{f'_c}}$	

$f_y =$ yield strength of steel
$\psi_t = 1.0$
$\psi_e = 1.0$ for no epoxy coating
d_b = diameter of steel reinforcement bar
λ = 1.0 for normal weight concrete
f'_c = compressive strength of concrete

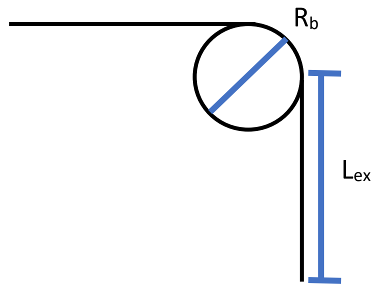
Bars (Compression)

The greater of

1) $\frac{f_y \gamma_r d_b}{50\lambda\sqrt{f'_c}}$
2) $0.0003 f_y \psi_r d_b$

λ = 1.0 for normal weight concrete
γ_r = 1.0

Stirrups



Size	R_b	L_{ex}
#3 through #5	$4d_b$	$12d_b$
#5 through #8	$6d_b$	$12d_b$

d_b = diameter of the rebar
R_b = radius of the arc
L_{ex} = see diagram above

Development Length Design Calculations

Bars

Development Length Bars												
Bar Size	dbar	fy	fc	Comp 1 L	Comp 2 L	Comp Max	Tension L	Govern	Rounded	Rounded ft	ft	in
8	1	60000	4000	19.0	18.0	19.0	47.4	47.4	47.5	3.958	3	11.5
5	0.625	60000	4000	11.9	11.3	11.9	23.7	23.7	23.75	1.979	1	11.75
3	0.375	60000	4000	7.1	6.8	7.1	14.2	14.2	14.25	1.188	1	2.25
14	1.693	80000	6000	35.0	40.6	40.6	87.4	40.6	40.75	3.396	3	4.75

Stirrups

For #4 Stirrups

R_b = 2 in

L_{ex} = 6 in

Appendix D

Storm Water Pollution Prevention Plan (SWPPP)

Storm Water Pollution Prevention Plan

for:

CABStone Hotel
1550 McConnor Pkwy
Schaumberg, IL 60173

Operator:

Focus Development and Construction
Josh Stark
100 South Wacker, Suite 2100
Chicago, Illinois 60606
joshs@workwithfocus.com
(224) 255-6117

Primary SWPPP Contact

Focus Development and Construction
Vicky Lee
100 South Wacker, Suite 2100
Chicago, Illinois 60606
vickyl@workwithfocus.com
(224) 255-6431

SWPPP Preparation Date:

3/14/2022

UPDES Permit Tracking Number*:

UTR_____

**This is the unique number assigned to your project after you have applied for coverage under the Utah Pollutant Discharge Elimination System (UPDES) construction general permit. If this template is filled out first, you can leave the tracking number blank until after you have applied for coverage.*

Contents

SECTION 1: CONTACT INFORMATION/ RESPONSIBLE PARTIES

1.1 Storm Water Team

Name and/or Position, and Contact	Responsibilities, Qualifications, and Training
CABStone Hotels, Inc Owners (702) 477-5822	
Vicky Lee Project Manager and SWPPP Contact vickyl@workwithfocus.com (224) 255-6431	- Onsite project manager – oversees all SWPPP-related inspections and operations - Certified SWPPP inspector – handles all SWPPP-related inspections, installation, and maintenance of best management practices

SECTION 2: NATURE OF CONSTRUCTION ACTIVITIES

2.1 Construction Site Estimates

The following are estimates for the construction site.

Total project area (lot size):	12.00 acres
Construction site area to be disturbed:	11.36 acres

2.2 Construction Activity Descriptions

Describe the general scope of the work for the project, major phases of construction, etc:
The project will include the construction of a six story reinforced concrete hotel with parking, landscaping, and roadway improvements. The work will be done in one phase from May 1st, 2022 to May 1st, 2025.

Describe any on-site and off-site construction support activity areas:
Staging and storage areas will be located on the lot itself.

Typical site business days and times:
Daily, 6 am to 10 pm.

2.3 Phase/Sequence of Construction Activity

Phase I

- Activity includes the construction of the hotel and surrounding improvements
- Duration of Phase: May 1, 2022-May 1, 2025
- BMPs associated with this phase:
  - Stabilized construction entrance
  - Dust control
  - Wheel wash
  - Silt fence
  - Portable toilets
  - Material delivery, storage, containment
  - Vehicle equipment fueling, cleaning
- Stabilization methods: Preserve natural vegetation

2.4 Maps

The SWPPP site map(s) are filed in Appendix A

SECTION 3: WATER QUALITY

3.1 Discharge Information

Does your project/site discharge storm water into a Municipal Separate Storm Sewer System (MS4)? ☒ Yes ☐ No

List the MS4 that receives the discharge from the construction project: **Cook County**

3.2 Receiving Waters

Names of Receiving Waters

Name of Receiving Water (first surface water that receives storm water or where storm system discharges to)	Is the water impaired or high quality?	If high quality: Is it Category 1 or 2? If impaired: List pollutants that the waterbody is impaired for
1. Busse Lake	☐ Not high quality/impaired ☒ Impaired, has approved TMDL ☐ Impaired, no TMDL ☐ High quality	Manganese

3.3 Impaired Waters

Description of additional precautions taken if you are discharging to an impaired surface water. State if no impairment causing pollutants are on site:

Additional precautions will be implemented as BMPs –

- **Stabilized construction entrance**
- **Dust control**
- **Grading practices**
- **Wheel wash**
- **Silt fence**
- **Portable toilets**

3.4 High Water Quality

N/A

SECTION 4: POLLUTION PREVENTION STANDARDS

4.1 Potential Sources of Pollution

Pollutant-Generating Activity	**Pollutants or Pollutant Constituents** (that could be discharged if exposed to storm water)	**Location on Site** (or reference SWPPP site map where this is shown)
Paving Operations	Silt, asphalt, concrete, debris, etc.	Refer to SWPPP site map
Portable Toilets	Solid and sanitary waste	Refer to SWPPP site map
Wheel Washing	Dirt and debris	Refer to SWPPP site map
Concrete/paint washout	Fuel	Refer to SWPPP site map
Delivery and Storing of Materials	Harmful Chemicals	Refer to SWPPP site map

4.2 Non-Storm Water Discharges

Authorized Non-Storm Water Discharges	Present	Comments/Controls
Discharges from emergency fire-fighting activities	☐ Y ☒ N	
Fire hydrant flushing	☐ Y ☒ N	
Properly managed landscape irrigation (excludes fertilizer injector systems)	☐ Y ☒ N	
Properly managed vehicle and equipment wash water with no soaps, solvents, or detergents	☐ Y ☒ N	
Water used to control dust	☐ Y ☒ N	
Drinking water, includes uncontaminated water line flushing	☐ Y ☒ N	
External building washdown with no soaps, solvents, detergents, or hazardous substances	☐ Y ☒ N	
Pavement wash waters with no detergents or toxic or hazardous materials. Must have a sediment basin, sediment trap, of similarly effective control prior to discharge.	☐ Y ☒ N	
Uncontaminated air conditioning or compressor condensate	☐ Y ☒ N	
Uncontaminated, non-turbid discharges of ground water (from natural sources) or spring water	☐ Y ☒ N	

Uncontaminated foundation or footing drains	☐ Y ☒ N	

4.3 Dewatering Practices

☒ Check box if section not applicable to this site

4.4 Natural Buffers or Equivalent Sediment Controls

Buffer Compliance Alternatives

Are there any surface waters within 50 feet of your project's earth disturbances?

☐ YES ☒ NO

SECTION 5: EROSION AND SEDIMENT CONTROLS – BMPS

5.1 List of Erosion and Sediment BMPs on Site

BMP Description: C105 Stabilized Construction Entrance (Refer to Appendix H for details)	
Installation Schedule: Beginning of construction or grading through completion of site improvements.	
Maintenance and Inspection:	Aggregate shall be added if the pad is no longer in accordance with the specifications. If the entrance is not working to keep streets clean, then install wheel wash, sweep streets, or wash streets if wash water can be collected. Bi-weekly maintenance schedule or as needed.
Responsible Staff:	Vicky Lee (224) 255-6431

BMP Description: C140 Dust Control (Refer to Appendix H for details)	
Installation Schedule:	Once soil is disturbed.
Maintenance and Inspection:	Spray disturbed soil with water to prevent the blowing of dust during construction activities.
Responsible Staff:	Vicky Lee (224) 255-6431

BMP Description: C106 Wheel Wash (Refer to Appendix H for details)

Installation Schedule:	Beginning of construction or grading through completion of site improvements.
Maintenance and Inspection:	Wheel wash water shall not be discharged into a storm drain or the site's storm water collection system. Use closed-loop recirculation or land application. Bi-weekly maintenance schedule or as needed.

BMP Description: C233 Silt Fence (Refer to Appendix H for details)	
Installation Schedule:	Commencement of grading through completion of site improvements.
Maintenance and Inspection:	Bi-weekly maintenance schedule or as needed.
Responsible Staff:	Vicky Lee (224) 255-6431

5.2 Linear Site Perimeter Control Exemption

☒ Check box if section not applicable to this site

5.3 Final Stabilization

Description of final stabilization practices and schedule:

Type of stabilization (vegetation/landscaped, graveled, paved, etc.)	**Location**	**Implementation Schedule**
Preservation of Existing Vegetation	All around area to be disturbed by construction	Throughout project

SECTION 6: BMP's - POLLUTION PREVENTION/OPERATIONAL CONTROLS

6.1 Spill Prevention and Response

When a spill from a hazardous source occurs, the following items should be addressed:

1st Priority: Protect all people
2nd Priority: Protect equipment and property
3rd Priority: Protect the environment.

The following steps should be taken if a spill occurs on site:

1. Make sure the spill area is safe to enter and that it does not pose an immediate threat to health or safety of any person.
2. Stop the spill source.
3. Check for hazards (flammable material, noxious fumes, cause of spill) – if flammable liquid, turn off engines and nearby electrical equipment. If serious hazards are present, leave area and call 911. LARGE SPILLS ARE LIKELY TO PRESENT A HAZARD.
4. Call co-workers and supervisor for assistance and to make them aware of the spill and potential dangers.
5. If possible, stop spill from entering drains (use absorbent or other material as necessary).
6. Stop spill from spreading (use absorbent or other material).
7. If spilled material has entered a storm sewer; contact the local Storm Water Department.
8. Clean up spilled material according to manufacturer specifications, for liquid spills use absorbent materials and do not flush area with water.
9. Properly dispose of cleaning materials and used absorbent material according to manufacturer specifications.

Emergency contacts for the project should be contacted if a spill occurs in excess of the reportable quantity listed above. Below is a list of emergency contacts:

EMERGENCY NUMBERS

Illinois Hazmat Response Officer 24 hrs	(217) 782-7860
Cook County Sheriff's Office	(708)-865-4700
Schaumberg Fire Department	(847) 885-6300
Schaumberg Police Department	(847) 882-3534
Staff Contact – Vicky Lee	(224) 255-6431

General Materials Handling Practices

The following general practices will be used throughout the project to reduce the potential for spills.

- Potential pollutants will be stored and used in a manner consistent with the manufacturer's instructions in a secure location. To the extent practicable, material storage areas should not be located near storm drain inlets and should be equipped with covers, roofs, or secondary containment as needed to prevent storm water from contacting stored materials. Chemicals that are not compatible (such as sodium bicarbonate and hydrochloric acid) shall be stored in segregated areas so that spilled materials cannot combine and react.

- Materials disposal will be in accordance with the manufacturer's instructions and applicable local, state, and federal regulations.

- Materials no longer required for construction will be removed from the site as soon as practicable.

- Adequate garbage, construction waste, and sanitary waste handling and disposal facilities will be provided to the extent necessary to keep the site clear of obstruction and BMPs clear and functional.

Specific Materials Handling Practices

- All pollutants, including waste materials and demolition debris, that occur on-site during construction will be handled in a way that does not contaminate storm water.

- All chemicals including liquid products, petroleum products, water treatment chemicals, and wastes stored on site will be covered and contained and protected from vandalism.

- Maintenance and repair of all equipment and vehicles involving oil changes, hydraulic system drain down, de-greasing operations, fuel tank drain down and removal, and other activities which may result in the accidental release of contaminants, will be conducted under cover during wet weather and on an impervious surface to prevent the release of contaminants into the ground. Materials spilled during maintenance operations will be cleaned up immediately and properly disposed of.

- Wheel wash water will be settled and discharged on site by infiltration. Wheel wash water will not be discharged to the storm water system or the storm water treatment system.

- Application of agricultural chemicals, including fertilizers and pesticides, will be conducted in a manner and at application rates that will not result in loss of chemical to storm water runoff. Manufacturers' recommendations will be followed for application rates and procedures.

- pH-modifying sources will be managed to prevent contamination of runoff and storm water collected on site. The most common sources of pH-modifying materials are bulk cement, cement kiln dust (CKD), fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters.

- A centralized Concrete Waste Management area will be provided for all on-site construction activities.

Spill Response

The primary objective in responding to a spill is to quickly contain the material(s) and prevent or minimize their migration into storm water runoff and conveyance systems. If the release has impacted on-site storm water, it is critical to contain the released materials on site and prevent their release into receiving waters.

If a spill of pollutants threatens storm water at the site, the spill response procedures outlined below must be implemented in a timely manner to prevent the release of pollutants.

- The site superintendent will be notified immediately when a spill, or the threat of a spill, is observed. The superintendent will assess the situation and determine the appropriate response.

- If spills represent an imminent threat of escaping facilities and entering the receiving waters, facility personnel will respond immediately to contain the release and notify the superintendent after the situation has been stabilized.

- Spill kits containing materials and equipment for spill response and cleanup will be readily available to the site.

- If oil sheen is observed on surface water (e.g., settling ponds, detention pond, swales), absorbent pads and/or booms will be applied to contain and remove the oil. The source of the oil sheen will also be identified and removed or repaired as necessary to prevent further releases.

- The site superintendent, or his designee, will be responsible for completing the spill reporting form and for reporting the spill to the appropriate state or local agency.

- Spill response equipment will be inspected and maintained as necessary to replace any materials used in spill response activities.

Notification

In the event of a spill, make the appropriate notification(s) consistent with the following procedures:

- Any spill of oil which 1) violates water quality standards, 2) produces a “sheen” on a surface water, or 3) causes a sludge or emulsion must be reported immediately by telephone to the site superintendent at the phone numbers listed at the beginning of this document.

- Any oil, hazardous substance, or hazardous waste release which exceeds the reportable quantity must be reported immediately by telephone to the site superintendent at the phone numbers listed at the beginning of the document.

Any discharges in 24 hours equal to or in excess of the reportable quantities listed in 40 CFR 117, 40 CFR 110, and 40 CFR 302 will be reported to the National Response Center and the Division of Water Quality (DWQ) as soon as practical after knowledge of the spill is known to the permittees. The permittee shall submit within 14 calendar days of knowledge of the release a written description of: the release (including the type and estimate of the amount of material released), the date that such release occurred, the circumstances leading to the release, and measures taken and/or planned to be taken to the Division of Water Quality (DWQ). The Storm Water Pollution Prevention Plan must be modified within14 calendar days of knowledge of the release to provide a description of the release, the circumstances leading to the release, and the date of the release. In addition, the plan must be reviewed to identify measures to prevent the reoccurrence of such releases and to respond to such releases, and the plan must be modified where appropriate.

Agency	Phone Number
National Response Center	(800) 424-8802
Division of Water Quality (DWQ) 24-Hr Reporting	(217) 782-3397
Illinois Department of Health Emergency Response	(312) 814-2793

Material	Media Released To	Reportable Quantity
Engine oil, fuel, hydraulic & brake fluid	Land	25 gallons
Paints, solvents, thinners	Land	100 lbs (13 gallons)
Engine oil, fuel, hydraulic & brake fluid	Water	Visible Sheen
Antifreeze, battery acid, gasoline, engine degreasers	Air, Land, Water	100 lbs (13 gallons)
Refrigerant	Air	1 lb

6.2 Pollution Prevention Controls

BMP Description: C153 Material Delivery, Storage and Containment (Refer to Appendix H for more details)	
Installation Schedule:	Beginning of construction or grading through completion of site improvements.
Maintenance and Inspection:	Inspect to ensure compliance with requirements of BMP. Bi-weekly maintenance schedule or as needed.
Responsible Staff:	Vicky Lee (224) 255-6431

BMP Description: C155 Vehicle Equipment Fueling / Cleaning (Refer to Appendix H for more details)	
Installation Schedule:	Beginning of construction or grading through completion of site improvements.
Maintenance and Inspection:	Inspect to ensure compliance with requirements of BMP. Provide on-going training.
Responsible Staff:	Vicky Lee (224) 255-6431

BMP Description: C151 Concrete Waste Management (Refer to Appendix H for more details)	
Installation Schedule:	Beginning of construction or grading through completion of site improvements.
Maintenance and Inspection:	Inspect to ensure compliance with concrete waste criteria. Provide on-going training. Bi-weekly maintenance schedule or as needed.
Responsible Staff:	Vicky Lee (224) 255-6431

BMP Description: C190 Portable Toilets (Refer to Appendix H for more details)	
Installation Schedule:	Beginning of construction or grading through completion of site improvements
Maintenance and Inspection:	Inspect for compliance to location, perimeter berm and continual service by licensed provider. Bi-weekly maintenance schedule or as needed.
Responsible Staff:	Vicky Lee (224) 255-6431

SECTION 7: SPECIAL CONDITIONS

7.1 Emergency Related Projects

Emergency-Related Project? ☐ Yes ☒ No

7.2 UIC Class 5 Injection Wells

☒ Check box if section not applicable to this site

7.3 Chemical Treatment

☒ Check box if section not applicable to this site

SECTION 8: INSPECTIONS & CORRECTIVE ACTIONS

8.1 Inspections

Minimum Inspection Schedule Requirements:

Standard Frequency:
☒ Once every 7 calendar days.

Inspection Reports are filed in Appendix C

8.2 Corrective Actions

Correction Action Report is filed in Appendix D.

8.3 Delegation of Authority

See the signed delegation of authority forms in Appendix E.

SECTION 9: RECORDKEEPING

9.1 Recordkeeping

Maintain all records in Appendices A-I

9.2 Log of Changes to the SWPPP

Description of the Amendment	Date of Amendment	Amendment Prepared by [Name(s) and Title]

SECTION 10: CERTIFICATION

Owner

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name:	Title:
Signature:	Date:

General Contractor

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name:	Title:
Signature:	Date:

SWPPP APPENDICES

Attach the following documentation to the SWPPP:

Appendix A – Site Maps

Appendix B – NOI

Appendix C – Inspection Reports

Appendix D –Corrective Action Report

Appendix E – Subcontractor Certifications/Agreements/Delegation of Authority (see CGP 9.16(1)b.)

Appendix F – Training Logs and Certifications (see CGP 6)

Appendix G – Additional Information (i.e., Other permits such as dewatering, stream alteration, wetland; and out of date swppp documents)

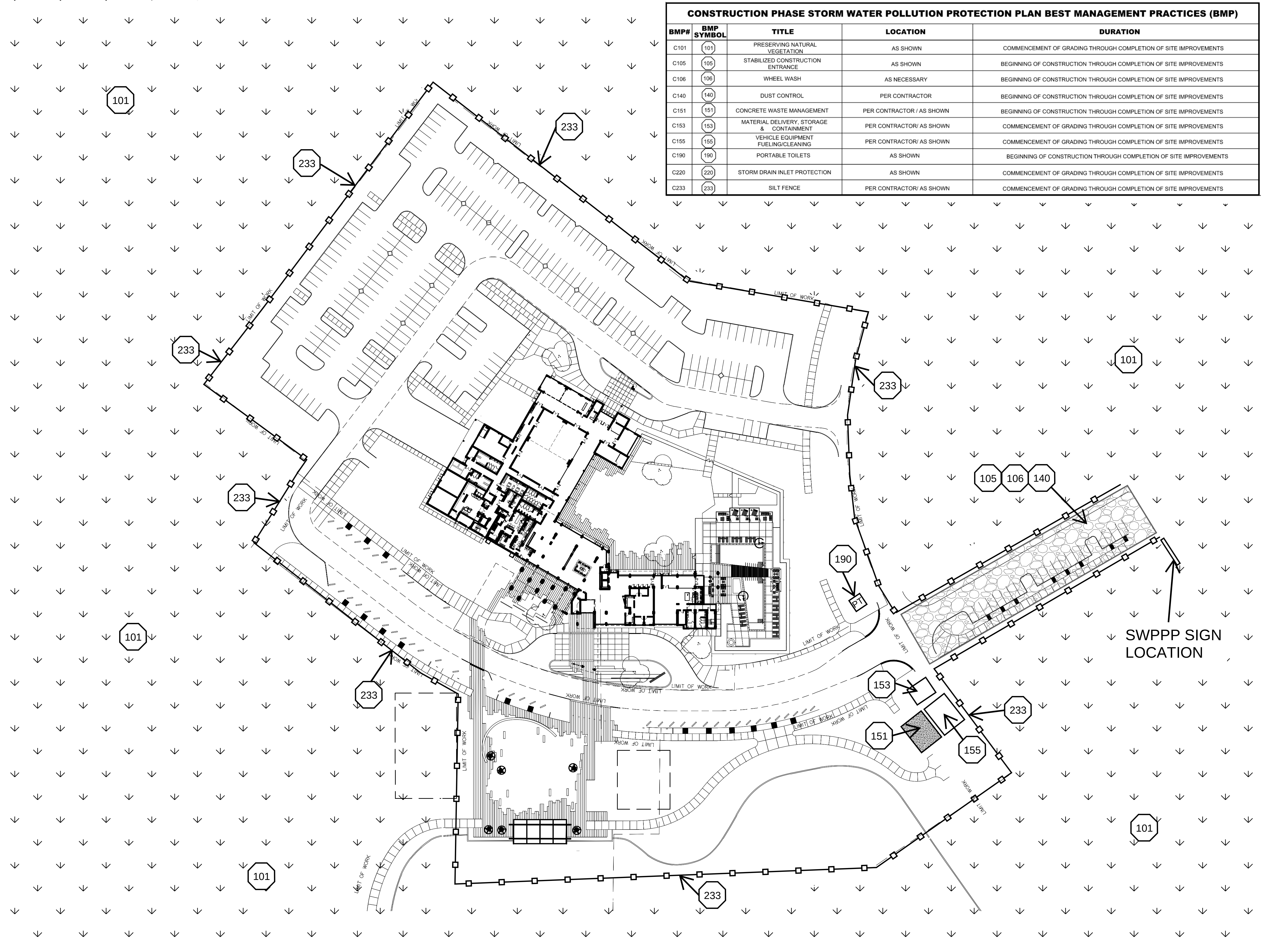
Appendix H – BMP Instruction and Detail Specifications

Appendix I – Construction General Permit

Appendix A: Site Maps

CONSTRUCTION PHASE STORM WATER POLLUTION PROTECTION PLAN BEST MANAGEMENT PRACTICES (BMP)

BMP#	BMP SYMBOL	TITLE	LOCATION	DURATION
C101	101	PRESERVING NATURAL VEGETATION	AS SHOWN	COMMENCEMENT OF GRADING THROUGH COMPLETION OF SITE IMPROVEMENTS
C105	105	STABILIZED CONSTRUCTION ENTRANCE	AS SHOWN	BEGINNING OF CONSTRUCTION THROUGH COMPLETION OF SITE IMPROVEMENTS
C106	106	WHEEL WASH	AS NECESSARY	BEGINNING OF CONSTRUCTION THROUGH COMPLETION OF SITE IMPROVEMENTS
C140	140	DUST CONTROL	PER CONTRACTOR	BEGINNING OF CONSTRUCTION THROUGH COMPLETION OF SITE IMPROVEMENTS
C151	151	CONCRETE WASTE MANAGEMENT	PER CONTRACTOR / AS SHOWN	BEGINNING OF CONSTRUCTION THROUGH COMPLETION OF SITE IMPROVEMENTS
C153	153	MATERIAL DELIVERY, STORAGE & CONTAINMENT	PER CONTRACTOR/ AS SHOWN	COMMENCEMENT OF GRADING THROUGH COMPLETION OF SITE IMPROVEMENTS
C155	155	VEHICLE EQUIPMENT FUELING/CLEANING	PER CONTRACTOR/ AS SHOWN	COMMENCEMENT OF GRADING THROUGH COMPLETION OF SITE IMPROVEMENTS
C190	190	PORTABLE TOILETS	AS SHOWN	BEGINNING OF CONSTRUCTION THROUGH COMPLETION OF SITE IMPROVEMENTS
C220	220	STORM DRAIN INLET PROTECTION	AS SHOWN	COMMENCEMENT OF GRADING THROUGH COMPLETION OF SITE IMPROVEMENTS
C233	233	SILT FENCE	PER CONTRACTOR/ AS SHOWN	COMMENCEMENT OF GRADING THROUGH COMPLETION OF SITE IMPROVEMENTS



Appendix B: NOI

Appendix C: Inspection Reports

Appendix C - Stormwater Construction Site Inspection Report

General Information			
Project Name			
NPDES Tracking No.		**Location**	
Date of Inspection		**Start/End Time**	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			
Inspector's Qualifications			
Describe present phase of construction			
Type of Inspection: ❑ Regular ❑ Pre-storm event ❑ During storm event ❑ Post-storm event			
Weather Information			
Has there been a storm event since the last inspection? ❑Yes ❑No **If yes, provide:** Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):			
Weather at time of this inspection? ❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snowing ❑ High Winds ❑ Other: Temperature:			
Have any discharges occurred since the last inspection? ❑Yes ❑No **If yes, describe:**			
Are there any discharges at the time of inspection? ❑Yes ❑No **If yes, describe:**			

Site-specific BMPs

- *Number the structural and non-structural BMPs identified in your SWPPP on your site map and list them below (add as many BMPs as necessary). Carry a copy of the numbered site map with you during your inspections. This list will ensure that you are inspecting all required BMPs at your site.*
- *Describe corrective actions initiated, date completed, and note the person that completed the work in the Corrective Action Log.*

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1		❑Yes ❑No	❑Yes ❑No	
2		❑Yes ❑No	❑Yes ❑No	
3		❑Yes ❑No	❑Yes ❑No	
4		❑Yes ❑No	❑Yes ❑No	
5		❑Yes ❑No	❑Yes ❑No	
6		❑Yes ❑No	❑Yes ❑No	
7		❑Yes ❑No	❑Yes ❑No	
8		❑Yes ❑No	❑Yes ❑No	
9		❑Yes ❑No	❑Yes ❑No	
10		❑Yes ❑No	❑Yes ❑No	
11		❑Yes ❑No	❑Yes ❑No	

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
12		❑Yes ❑No	❑Yes ❑No	
13		❑Yes ❑No	❑Yes ❑No	
14		❑Yes ❑No	❑Yes ❑No	
15		❑Yes ❑No	❑Yes ❑No	
16		❑Yes ❑No	❑Yes ❑No	
17		❑Yes ❑No	❑Yes ❑No	
18		❑Yes ❑No	❑Yes ❑No	
19		❑Yes ❑No	❑Yes ❑No	
20		❑Yes ❑No	❑Yes ❑No	

Overall Site Issues
Below are some general site issues that should be assessed during inspections. Customize this list as needed for conditions at your site.

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
1	Are all slopes and disturbed areas not actively being worked properly stabilized?	❑Yes ❑No	❑Yes ❑No	
2	Are natural resource areas (e.g., streams, wetlands, mature trees, etc.) protected with barriers or similar BMPs?	❑Yes ❑No	❑Yes ❑No	
3	Are perimeter controls and sediment barriers adequately installed (keyed into substrate) and maintained?	❑Yes ❑No	❑Yes ❑No	
4	Are discharge points and receiving waters free of any sediment deposits?	❑Yes ❑No	❑Yes ❑No	
5	Are storm drain inlets properly protected?	❑Yes ❑No	❑Yes ❑No	
6	Is the construction exit preventing sediment from being tracked into the street?	❑Yes ❑No	❑Yes ❑No	
7	Is trash/litter from work areas collected and placed in covered dumpsters?	❑Yes ❑No	❑Yes ❑No	

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
8	Are washout facilities (e.g., paint, stucco, concrete) available, clearly marked, and maintained?	❑Yes ❑No	❑Yes ❑No	
9	Are vehicle and equipment fueling, cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	❑Yes ❑No	❑Yes ❑No	
10	Are materials that are potential stormwater contaminants stored inside or under cover?	❑Yes ❑No	❑Yes ❑No	
11	Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	❑Yes ❑No	❑Yes ❑No	
12	(Other)	❑Yes ❑No	❑Yes ❑No	

Non-Compliance

Describe any incidents of non-compliance not described above:

CERTIFICATION STATEMENT

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name and title: ____

Signature:____ **Date:**____________________

Appendix D –Corrective Action Report

Project Name:
SWPPP Contact:

Inspection Date	Inspector Name(s)	Description of BMP Deficiency	Corrective Action Needed (including planned date/responsible person)	Date Action Taken/Responsible person

Appendix E: Subcontractor Certifications/Agreements/Delegation of Authority (CGP 9.16.(1)b.)

SUBCONTRACTOR CERTIFICATION
STORM WATER POLLUTION PREVENTION PLAN

Project Number: ______________________________

Project Title: ______________________________

Operator(s): ______________________________

As a subcontractor, you are required to comply with the Storm water Pollution Prevention Plan (SWPPP) for any work that you perform on-site. Any person or group who violates any condition of the SWPPP may be subject to substantial penalties or loss of contract. You are encouraged to advise each of your employees working on this project of the requirements of the SWPPP. A copy of the SWPPP is available for your review at request.

Each subcontractor engaged in activities at the construction site that could impact storm water must be identified and sign the following certification statement:

I certify under the penalty of law that I have read and understand the terms and conditions of the SWPPP for the above designated project and agree to follow the BMPs and practices described in the SWPPP.

This certification is hereby signed in reference to the above named project:

Company: ______________________________

Address: ______________________________

Telephone Number: ____________________

Type of construction service to be provided: ______________________________

____

____

Signature: ____________________

Title: ____________________

Date: ____________________

Delegation of Authority

I, ____________________________, hereby designate the person or specifically described position below to be a duly authorized representative for the purpose of overseeing compliance with environmental requirements, including the UPDES "General Permit for Storm Water Discharges Associated with Construction Activity" (CGP), at the construction site:

____, Permit No. UTR_________________

The designee is authorized to sign all reports required by the Permit and other information requested by the Director of the Utah Division of Water Quality, or by an authorized representative of the Executive Secretary.

Name of Person or Position: ____

Owner/Operator:____

Mailing Address: ____

City, State, Zip Code: ____

Phone Number: ____

By signing this authorization, I confirm that I meet the requirements to make such a designation as set forth in Part 9.16 of the CGP, and that the designee above meets the definition of a "duly authorized representative" as set forth in Part 9.16.b. of the CGP.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: ____

Title: ____

Signature: ____

Date: ____________________________

Appendix F: Training Logs and Certifications (see CGP 6)

A sample training log has been included in this appendix to keep track of trainings that have been provided. At a minimum, storm water team members that require training should be provided with the following if it relates to their duties (CGP Part 6.3.):

- The permit deadlines associated with installation, maintenance, and removal of storm water controls and with stabilization;
- The location of all storm water controls on the site required by this permit and how they are to be maintained;
- The proper procedures to follow with respect to the permit's pollution prevention requirements; and
- When and how to conduct inspections, record applicable findings, and take corrective actions

Certifications for SWPPP inspectors or writers can also be placed in this appendix.

Appendix F –SWPPP Training Log

Storm Water Pollution Prevention Training Log

Project Name:

Project Location:

Instructor's Name(s):

Instructor's Title(s):

Course Location: ______________________________ Date: ________________

Course Length (hours): __________________________

Storm Water Training Topic: *(check as appropriate)*

- ❑ **Erosion Control BMPs**
- ❑ **Emergency Procedures**
- ❑ **Sediment Control BMPs**
- ❑ **Good Housekeeping BMPs**
- ❑ **Non-Storm Water BMPs**

Specific Training Objective:____

____

Attendee Roster: *(attach additional pages as necessary)*

No.	Name of Attendee	Company
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Appendix G: Additional Information

Appendix H: BMP Instruction and Detail Specifications

Use this appendix if complete BMP specifications are not provided in Section 5 or 6 of the SWPPP.

BMP C101: PRESERVING NATURAL VEGETATION

Purpose

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20-30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

- *Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.*
- As required by local governments.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and grasses. The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees.
- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Maintenance Standards

- Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.
- If tree roots have been exposed or injured, “prune” cleanly directly above the damaged roots and recover with native soils. Treatment of sap flowing trees (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C103: HIGH VISIBILITY PLASTIC OR METAL FENCE

Purpose

Fencing is intended to: (1) restrict clearing to approved limits; (2) prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed; (3) limit construction traffic to designated construction entrances or roads; and, (4) protect areas where marking with survey tape may not provide adequate protection.

Conditions of Use

To establish clearing limits, plastic or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

- High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method.
- Metal fences shall be designed and installed according to the manufacturer's specifications.
- Metal fences shall be at least 3 feet high and must be highly visible.
- Fences shall not be wired or stapled to trees.

Maintenance Standards

- If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored.

BMP C105: STABILIZED CONSTRUCTION ENTRANCE

Purpose

Construction entrances are stabilized to reduce the amount of sediment transported onto paved roads by vehicles or equipment by constructing a stabilized pad of course aggregate at entrances to construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will be leaving a construction site and traveling on paved roads or other paved areas within 1,000 feet of the site.

Design and Installation Specifications

- See Figure for details.

- A separation geotextile shall be placed under the aggregate to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

Grab Tensile Strength (ASTM D4751)	200 psi min.
Grab Tensile Elongation (ASTM D4632)	30% max.
Mullen Burst Strength (ASTM D3786-80a)	400 psi min.
AOS (ASTM D4751)	20-45 (U.S. standard sieve size)

- Consider early installation of the first lift of asphalt in areas that will paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.

- Fencing (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.

- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.

Maintenance Standards

- Additional aggregate shall be added if the pad is no longer in accordance with the specifications.

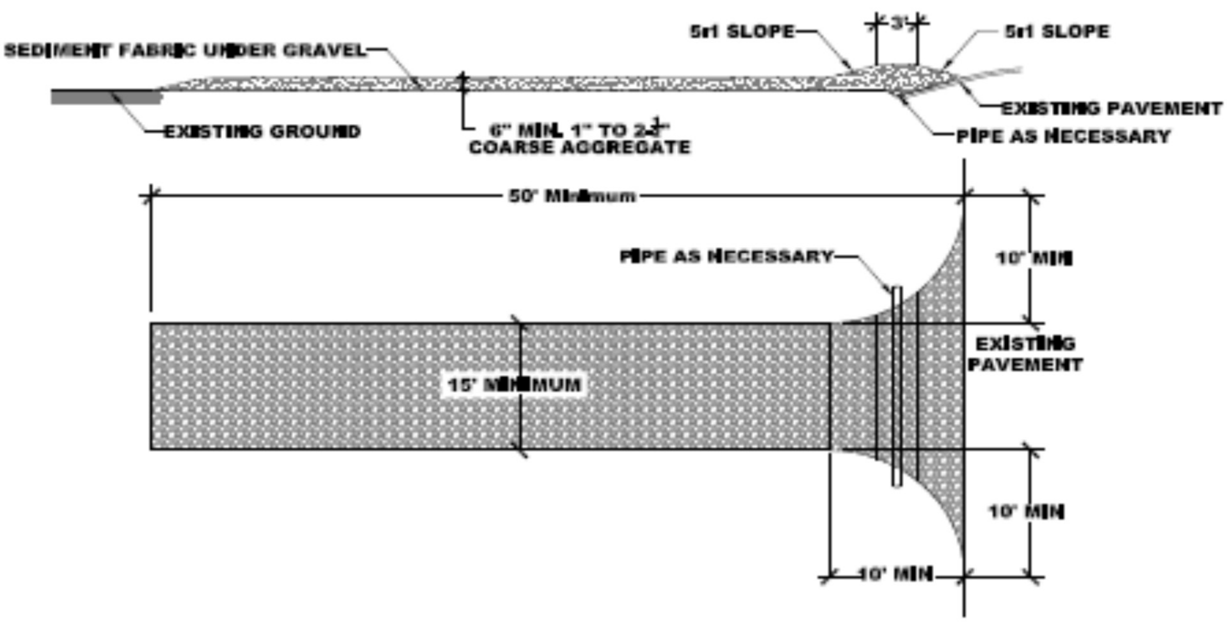
- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash.

- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump shall be considered. The sediment would then be washed into the sump where it can be controlled.

- Any aggregate that is loosened from the pad, which end up on the roadway shall be removed immediately.

- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP C103) shall be installed to control traffic.

- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.



STABILIZED CONSTRUCTION ENTRANCE SHALL BE MAINTAINED UNTIL SUCH TIME AS ROADS ARE ASPHALTED AND INDIVIDUAL HOME LOTS ARE BEING DEVELOPED.

BMP C106: WHEEL WASH

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

Conditions of Use

When a stabilized construction entrance (see BMP C105) is not preventing sediment from being tracked onto pavement, a wheel wash is to be used.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.

- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.

Design and Installation Specifications

Suggested details are shown in the Figure. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.

Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance.

Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.

Midpoint spray nozzles are only needed in extremely muddy conditions.

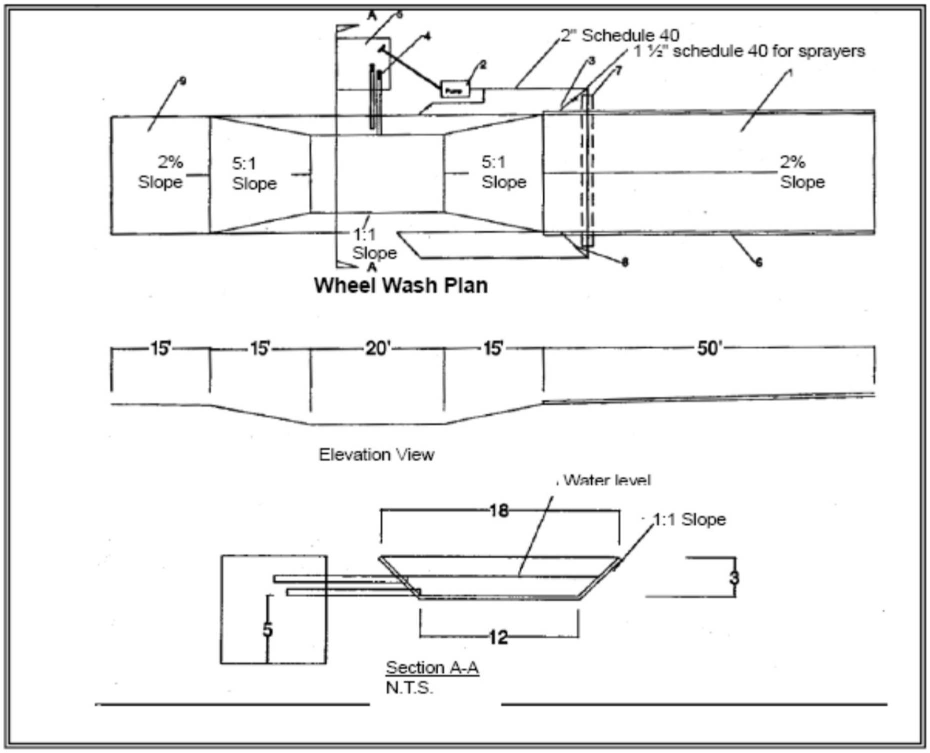
Wheel wash systems should be designed with a small grade change, 6 to 12 inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment. A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time.

Maintenance Standards

The wheel wash should start out the day with fresh water.

The wash water should be changed a minimum of once per day. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often.

Wheel wash or tire bath wastewater shall be discharged to a separate onsite treatment system, such as closed-loop recirculation or land application, or to the sanitary sewer with proper local sewer district approval.



Notes:
1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so can be cleaned with trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

BMP C108: GRADING PRACTICES

Purpose

Control soil erosion by minimizing the exposure of bare soil to erosive forces. This is done by:

- Limiting the amount of land disturbed at one time in preparation for construction.
- Limiting the amount of time between the disturbance of soil and protection or stabilization of disturbed soils, and
- Using grading practices to protect exposed soils susceptible to storm water runoff.

Related practices include preservation of existing vegetation, erosion control practices and sediment control practices.

Conditions of Use

- The specific approach to grading on a particular site depends on the conditions of the site and surrounding land; engineering judgment is required to design the approach best suited for each site.

Design and Installation Specifications

- Limit the area of disturbance to those areas requiring grading. This preserves existing vegetation and reduces the vulnerability of soil to erosion.
- Based on erosion potential and sediment control measures on the site, establish what areas are to be graded at one time.
- An undisturbed buffer zone containing vegetation at the lowest elevation of a construction site can reduce the transport of sediment offsite.
- Initiate soil protection measures during the course of work to minimize the length of time soil is exposed to erosive forces.
- Conduct work in stages so that construction or soil stabilization occurs promptly after disturbance of soil.
- Establish a schedule governing the stabilization of disturbed slopes, both in terms of passage of time since commencement and completion of disturbance and in terms of planting season.
- Leaving the surface of the disturbed soil graded in a roughened condition (not smooth) can reduce the quantity and velocity of storm water runoff.

- Prevent storm water runoff from running onto steep slopes from above.

- Avoid long, steep cut or fill slopes that allow runoff water of sufficient quantity or velocity to cut into and erode the slope.

Maintenance Standards

- Practices may need to vary from the approved plan if erosion problems appear when storm water runoff occurs.

BMP C120: TEMPORARY AND PERMANENT SEEDING

Purpose

Seeding is intended to reduce erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use

- Seeding may be used throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 90 days.

- Channels that will be vegetated should be installed before major earthwork and hydroseeded with a Bonded Fiber Matrix. The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch. With channels that will have high flows, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed in the bottom of the ditch over hydromulch and blankets.

- Retention/detention ponds should be seeded as required.

- Mulch is required at all times because it protects seeds from heat, moisture loss, and transport due to runoff.

- All disturbed areas shall be reviewed in late August to early September and all seeding should be completed by the end of September.

- At final site stabilization, all disturbed areas not otherwise vegetated or stabilized shall be seeded and mulched. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions or geotextiles) which will prevent erosion.

Design and Installation Specifications

- Seeding should be done during those seasons most conducive to growth.

- To prevent seed from being washed away, confirm that all required surface water control measures have been installed.

- The seedbed should be firm and rough. All soil should be roughened no matter what the slope. If compaction is required for engineering purposes, slopes must be track walked before seeding. Backblading or smoothing of slopes greater than 4:1 is not allowed if they are to be seeded.

- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier.

- Mulch is always required for seeding. Mulch can be applied on top of the seed or simultaneously by hydroseeding.

- On steep slopes, Bonded Fiber Matrix (BFM) or Mechanically Bonded Fiber Matrix (MBFM) products should be used.

- All seed mixes to consist of local grasses and plants which will blend with undisturbed areas of the project.

Maintenance Standards

- Any seeded areas that fail to establish at least 80 percent cover shall be reseeded. If reseeding is ineffective, an alternate method, such as sodding, mulching, or nets/blankets, shall be used.

- After adequate cover is achieved, any areas that experience erosion shall be reseeded and protected by mulch. If the erosion problem is drainage related, the problem shall be fixed and the eroded area reseeded and protected by mulch.

- If necessary, seeded areas shall be supplied with adequate moisture, but not watered to the extent that it causes runoff.

- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam).

- Stripping shall be confined to the immediate construction area. A 4- to 6- inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2:1.

- Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.

Maintenance Standards

- **INSPECT STOCKPILES REGULARLY, ESPECIALLY AFTER LARGE STORM EVENTS. STABILIZE ANY AREAS THAT**

HAVE ERODED.

BMP C130: SURFACE ROUGHENING

Purpose

Surface roughening aids in the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and provides for sediment trapping through the provision of a rough soil surface. Horizontal depressions are created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Conditions for Use

- All slopes steeper than 3:1 and greater than 5 vertical feet require surface roughening.
- Areas with grades steeper than 3:1 should be roughened to a depth of 2 to 4 inches prior to seeding.
- Areas that will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.
- Slopes with a stable rock face do not require roughening.
- Slopes where mowing is planned should not be excessively roughened.

Design and Installation Specifications

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. See Figure 4.6 for tracking and contour furrows. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

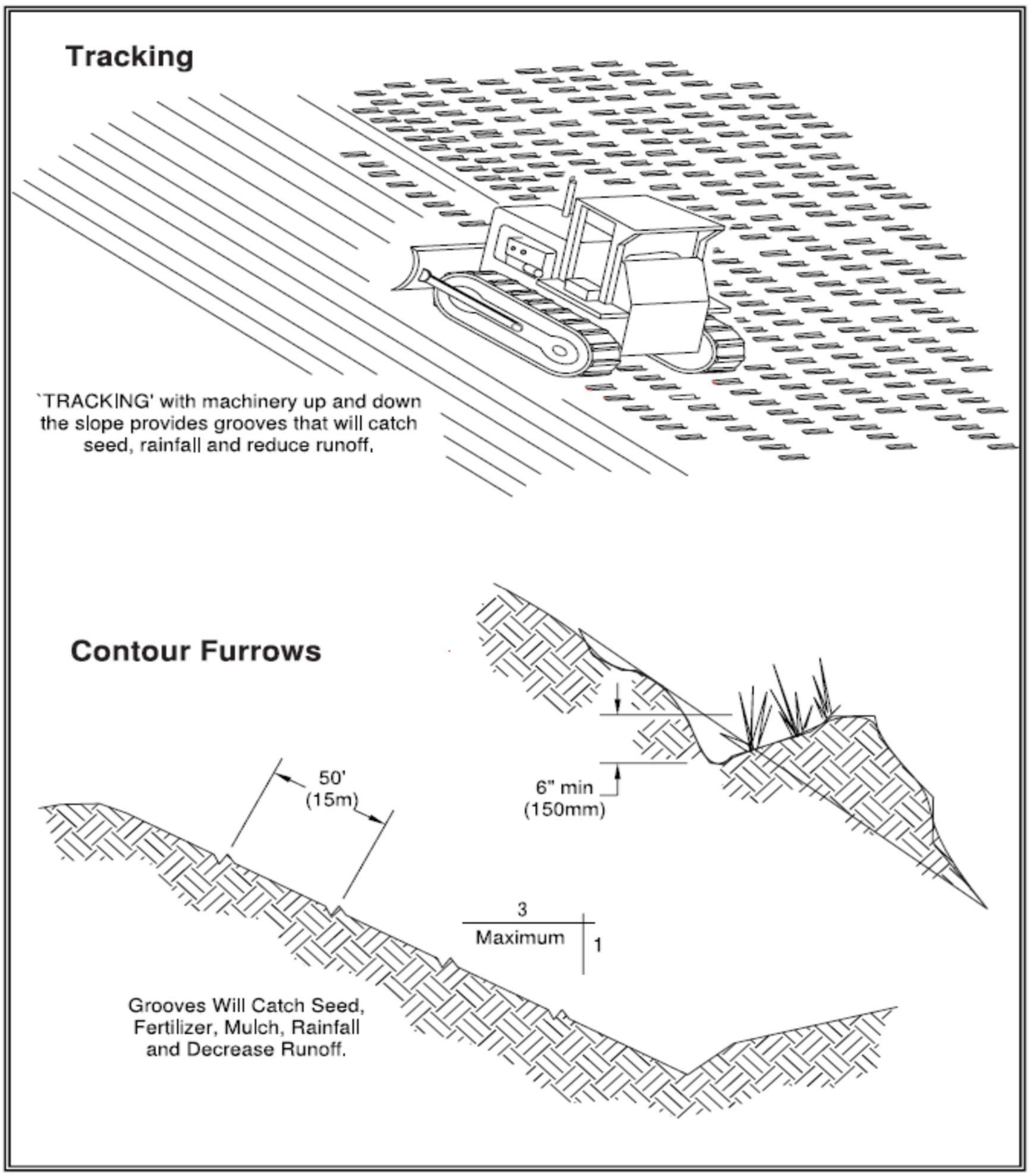
- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Areas that will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.

- Graded areas with slopes greater than 3:1 but less than 2:1 should be roughened before seeding. This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, leaving a pattern of cleat imprints parallel to slope contours.

- Tracking is done by operating equipment up and down the slope to leave horizontal depressions in the soil.

Maintenance Standards

- Areas that are graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be re- graded and re-seeded immediately



BMP C140: DUST CONTROL

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions for Use

- In areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely

Design and Installation Specifications

- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition, if stable. Maintain the original ground cover as long as practical.

- Sprinkle the site with water until surface is wet. Repeat as needed.

- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM.

- PAM (BMP C126) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone.

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.

- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.

- Encourage the use of alternate, paved routes, if available.

- Restrict use by tracked vehicles and heavy trucks to prevent damage to road surface and base.

- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.

- Use vacuum street sweepers.
- Remove mud and other dirt promptly so it does not dry and then turn into dust.
- Limit dust-causing work on windy days.

Maintenance Standards

- Respray area as necessary to keep dust to a minimum.

BMP C151: CONCRETE WASTE MANAGEMENT

Purpose

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. This BMP is intended to minimize and eliminate concrete process water and slurry from entering the storm water system.

Conditions for Use

Any time concrete is used, these management practices shall be utilized. Concrete construction projects include, but are not limited to, the following:

- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors

Design and Installation Specifications

- Store wet and dry materials under cover and away from drainage areas.
- Create designated concrete cleanout area by excavation or installing berms according to BMP C200.
- Avoid mixing excess amounts of fresh concrete on-site.
- Perform washout of concrete trucks off-site or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets or vacant properties.
- Do not allow excess concrete to be dumped on-site, except in designated areas.
- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water into a bermed or level area.

- Train employees, contractors and subcontractors in proper concrete waste management.

Maintenance Standards

- Inspect subcontractors to ensure that concrete wastes are being properly managed.
- If using a temporary pit, dispose hardened concrete on a regular basis.

BMP C153: MATERIAL DELIVERY, STORAGE AND CONTAINMENT

Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in a designated area, and installing secondary containment.

Conditions of Use

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil and grease
- Soil stabilizers and binders (e.g. Polyacrylamide)
- Fertilizers, pesticides and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage on-site should be minimized.
- Hazardous materials should be handled as infrequently as possible.

- During the wet weather season (Oct 1 – April 30), consider storing materials in a covered area.

- Materials should be stored in secondary containments, such as earthen dikes.

- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.

Material Storage Areas and Secondary Containment Practices:

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.

- Temporary secondary containment facilities shall provide for a spill containment volume able to contain precipitation from a 25 year, 24 hour storm event, plus 10% of the total enclosed container volume of all containers, or 110% of the capacity of the largest container within its boundary, whichever is greater.

- Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.

- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

- During the wet weather season (Oct 1 – April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.

- Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill clean-up material (spill kit).

BMP C155: VEHICLE EQUIPMENT FUELING/CLEANING

Purpose

Prevent or reduce impacts to storm water due to fuel spills, fuel leaks and discharge of pollutants from vehicle and equipment cleaning by the use of off-site facilities, performing activities in designated and controlled areas only and training of employees and subcontractors.

Conditions of Use

- Sending vehicles/equipment off-site should be done in conjunction with Stabilized Construction Entrance.

Design and Installation Specifications

- Use off-site fueling stations and commercial washing facilities as much as possible. Fueling or cleaning vehicles and equipment outdoors or in areas where fuel may spill/leak or wash water flow onto paved surfaces or into drainage pathways can pollute storm water. If you fuel or clean a large number of vehicles or pieces of equipment, consider using off-site stations. These businesses are better equipped to handle fuel, spills and disposal of wash waters properly.

- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runoff of storm water and the runoff of spills. Discourage "topping-off" of fuel tanks.

- Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks. Place a stockpile of spill cleanup materials where it will be readily accessible. Use absorbent materials promptly and dispose of properly.

- Carry out all Federal and State requirements regarding stationary above ground storage tanks. Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time. Train employees and subcontractors in proper fueling and cleanup procedures.

- If washing must occur on-site, use designated, bermed wash areas to prevent wash water contact with storm water, creeks, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.

- Use as little water as possible to avoid having to install erosion and sediment controls for the wash area. Use phosphate-free biodegradable soaps. Educate employees and subcontractors on pollution prevention measures. Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.

Maintenance Standards

- Keep ample supplies of spill cleanup materials on-site.
- Inspect fueling areas and storage tanks on a regular schedule.
- Minimal, some berm repair may be necessary.

BMP C190: PORTABLE TOILETS

Purpose

Provide temporary on-site sanitary facilities for construction personnel.

Conditions of Use

- All sites with no permanent sanitary facilities or where permanent facilities are too far from job activities.

Design and Installation Specifications

- Locate portable toilets in convenient locations throughout the site.
- Prepare level, gravel surface and provide clear access to the toilets for servicing and for on-site personnel.
- Place portable toilets at least ten feet away from storm drains and secure to ground.

Maintenance Standards

- Regular inspection and waste collection must be completed by licensed service provider.
- The area below the outlet must be stabilized with a riprap apron or other suitable improvement.
- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.

Maintenance Standards

Check inlet and outlet points regularly, especially after storms.

The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, the headwall should be reinforced with compacted earth or sand bags.

BMP C220: STORM DRAIN INLET PROTECTION

Purpose

To prevent coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Protection should be provided for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless the runoff that enters the catch basin will be conveyed to a sediment pond or trap. Inlet protection may be used anywhere to protect the drainage system. It is likely that the drainage system will still require cleaning.

The following table lists several options for inlet protection. All of the methods for storm drain inlet protection are prone to plugging and require a high frequency of maintenance. Drainage areas should be limited to 1 acre or less. Emergency overflows may be required where stormwater ponding would cause a hazard. If an emergency overflow is provided, additional end-of-pipe treatment may be required.

Storm Drain Inlet Protection			
Type of Inlet Protection	**Emergency Overflow**	**Applicable for Paved/Earthen Surfaces**	**Conditions of Use**
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding will Occur	Earthen	Applicable for heavy flows. Easy to maintain. Large area Requirement: 30’x30’/acre
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No		Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin and curb inlet filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Catch basin and curb inlet filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb inlet protection with straw bales or waddle	Small capacity overflow	Paved	Used for sturdy, more compact installation.
block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.

Design and Installation Specifications

Excavated Drop Inlet Protection - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- Depth 1-2 ft as measured from the crest of the inlet structure.
- Side Slopes of excavation no steeper than 2:1.
- Minimum volume of excavation 35 cubic yards.
- Shape basin to fit site with longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water problems.
- Clear the area of all debris.
- Grade the approach to the inlet uniformly.
- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.
- It may be necessary to build a temporary dike to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter - A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure.

- Height 1 to 2 feet above inlet.
- Recess the first row 2 inches into the ground for stability.
- Support subsequent courses by placing a 2x4 through the block opening.
- Do not use mortar.
- Lay some blocks in the bottom row on their side for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel just below the top of blocks on slopes of 2:1 or flatter.
- An alternative design is a gravel donut or wattle.
- 1-foot wide level stone area between the structure and the inlet.

Gravel and Wire Mesh Filter - A gravel barrier placed over the top of the inlet. This structure does not provide an overflow.

- Hardware cloth or comparable wire mesh with ½-inch openings.
- Coarse aggregate.
- Height 1-foot or more, 18 inches wider than inlet on all sides.
- Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.
- If more than one strip of mesh is necessary, overlap the strips.
- Place coarse aggregate over the wire mesh.
- The depth of the gravel should be at least 12 inches over the entire inlet opening and extend at least 18 inches on all sides.

Catchbasin and Curb Inlet Filters – Inserts must be installed according to manufacturer's details and requirements. Inspection and maintenance may be required often based on sediment loads and rainfall events.

- For Nyloplast curb inlets, use Storm-PURE Catch Basin Insert or approved equal.
- For standard concrete curb inlets, use Siltsack manufactured by ACF Environmental, or approved equal.
- High-flow bypass that will not clog under normal use at a construction site.
- The catchbasin filter is inserted in the catchbasin just below the grating.

Curb Inlet Protection with Straw Bales or Waddle – Barrier formed around a curb inlet with straw bales and according to BMP 230 or barrier using commercially available "waddle" products which incorporate filtering material or media. Install "waddle" applications according to manufacturer's specifications.

Block and Gravel Curb Inlet Protection – Barrier formed around an inlet with concrete blocks and gravel. See Figure.

- Wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.

- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.

- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.

- Place wire mesh over the outside vertical face.

- Pile coarse aggregate against the wire to the top of the barrier.

Curb and Gutter Sediment Barrier – Sandbag, rock berm or straw bale 2 feet high and 2 feet wide in a horseshoe shape. See Figure.

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 2 feet high and 2 feet wide, at least 2 feet from the inlet.

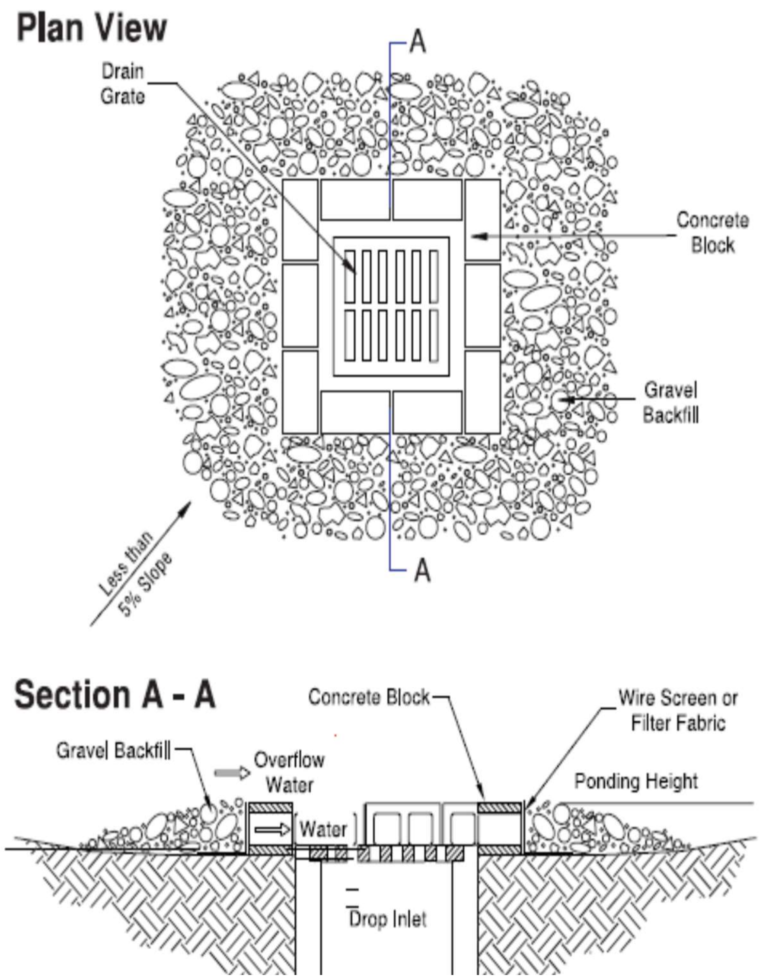
- Construct a horseshoe shaped sedimentation trap on the outside of the berm sized to sediment trap standards for protecting a culvert inlet.

Maintenance Standards

- Catch basin filters should be inspected frequently, especially after storm events. If the insert becomes clogged, it should be cleaned or replaced.

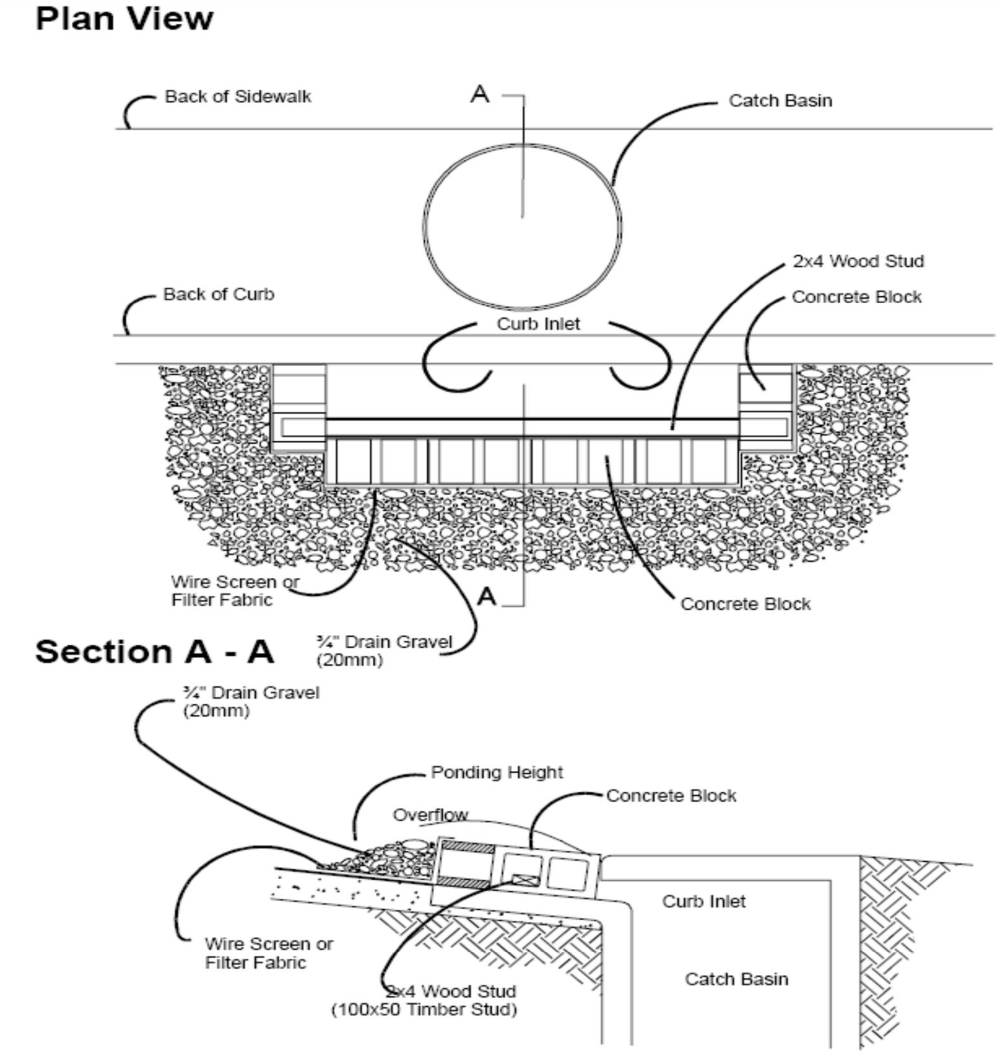
- For systems using stone filters: If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.

- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.



Notes:
1. Drop inlet sediment barriers are to be used for small, nearly level drainage areas. (less than 5%)
2. Excavate a basin of sufficient size adjacent to the drop inlet.
3. The top of the structure (ponding height) must be well below the ground elevation downslope to prevent runoff from bypassing the inlet. A temporary dike may be necessary on the dowslope side of the structure.

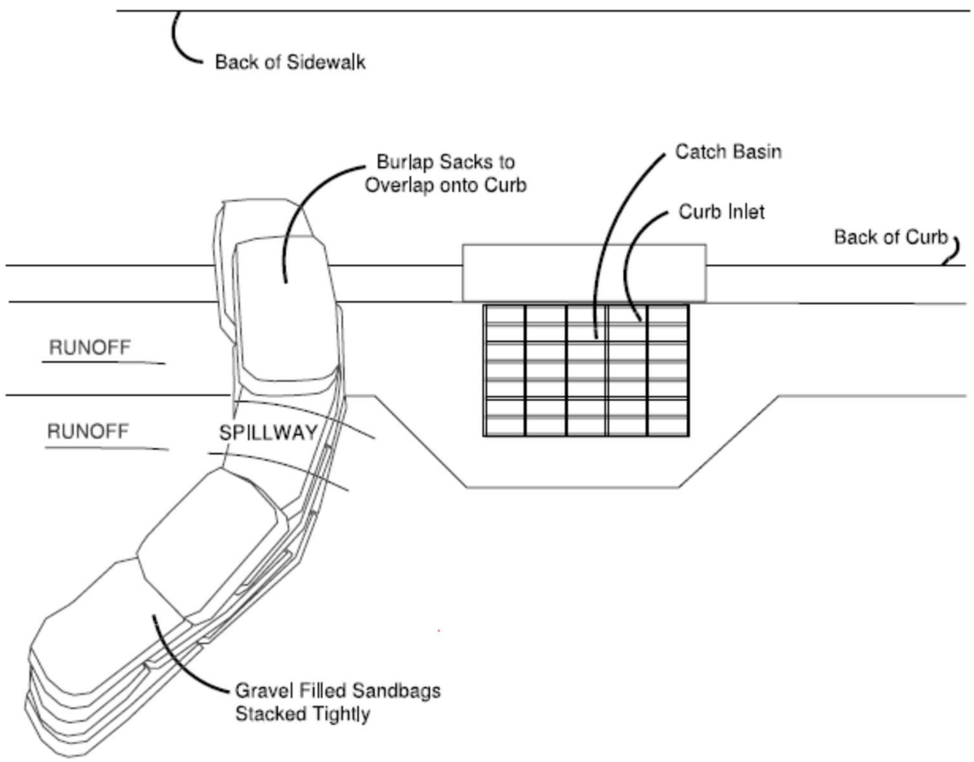
Figure 4.14 – Block and Gravel Filter



NOTES:
1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure 4.15 – Block and Gravel Curb Inlet Protection

Plan View



NOTES:
1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven `geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

BMP C233: SILT FENCE

Purpose

Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure for details on silt fence construction.

Conditions of Use

Silt fence may be used downslope of all disturbed areas.

- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a silt fence, rather than by a sediment pond, is when the area draining to the fence is one acre or less and flow rates are less than 0.5 cfs.

- Silt fences should not be constructed in streams or used in V-shaped ditches. They are not an adequate method of silt control for anything deeper than sheet or overland flow.

Design and Installation Specifications

- Used for drainage areas resulting in sheet or overland flow rather than concentrated flows.

- Maximum slope steepness (normal (perpendicular) to fence line) 2:1.

- Maximum sheet or overland flow path length to the fence of 150 feet.

- No flows greater than 0.5 cfs.

- The geotextile used shall meet the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in the following Table):

- Standard strength fabrics shall be supported with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric. Silt fence materials are available that have synthetic mesh backing attached.

- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F.

- Standard Notes for construction plans and specifications follow. Refer to Figure for standard silt fence details.

The contractor shall install and maintain temporary silt fences at the locations shown in the Plans. The silt fences shall be constructed in the areas of clearing, grading, or drainage prior to starting those activities. A silt fence shall not be considered temporary if the silt fence must function beyond the life of the contract. The silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.

The minimum height of the top of silt fence shall be 2 feet and the maximum height shall be 2½ feet above the original ground surface.

The geotextile shall be attached on the up-slope side of the posts and support system with staples, wire, or in accordance with the manufacturer's recommendations. The geotextile shall be attached to the posts in a manner that reduces the potential for geotextile tearing at the staples, wire, or other connection device. Silt fence back-up support for the geotextile in the form of a wire or plastic mesh is dependent on the properties of the geotextile selected for use. If wire or plastic back-up mesh is used, the mesh shall be fastened securely to the up-slope of the posts with the geotextile being up-slope of the mesh back-up support.

The geotextile at the bottom of the fence shall be buried in a trench to a minimum depth of 4 inches below the ground surface. The trench shall be backfilled and the soil tamped in place over the buried portion of the geotextile, such that no flow can pass beneath the fence and scouring can not occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the trench a minimum of 3 inches.

The fence posts shall be placed or driven a minimum of 18 inches. A minimum depth of 12 inches is allowed if topsoil or other soft subgrade soil is not present and a minimum depth of 18 inches cannot be reached. Fence post depths shall be increased by 6 inches if the fence is located on slopes of 3:1 or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.

Silt fences shall be located on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.
If the fence must cross contours, with the exception of the ends of the fence, gravel check dams placed perpendicular to the back of the fence shall be used to minimize concentrated flow and erosion along the back of the fence. The gravel check dams shall be approximately 1- foot deep at the back of the fence. It shall be continued perpendicular
to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence. The gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. The gravel check dams shall be located every 10 feet along the fence where the fence must cross contours. The slope of the fence line where contours must be crossed shall not be steeper than 3:1.

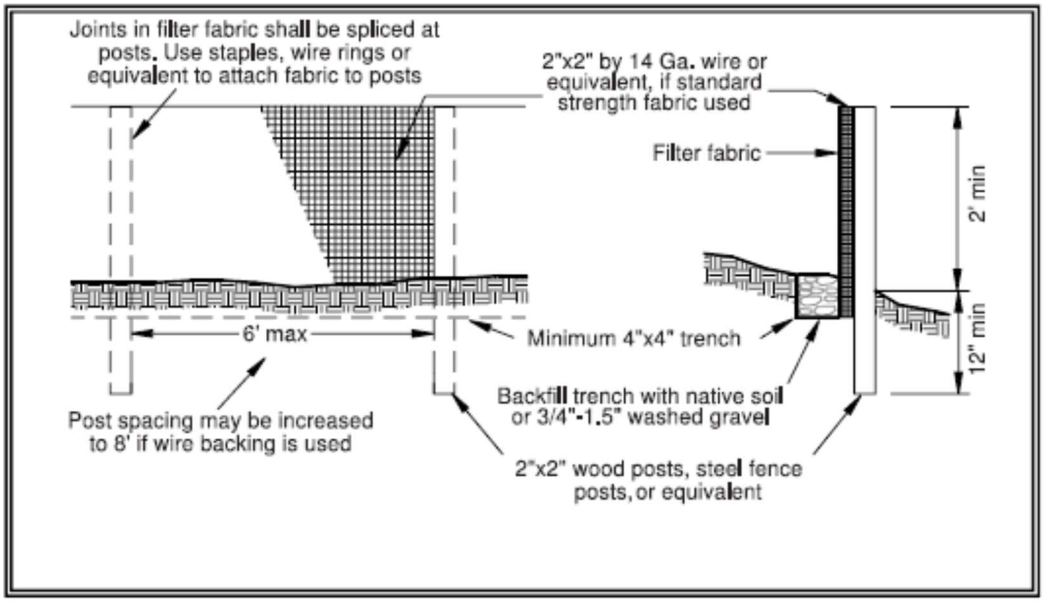
Wood, steel or equivalent posts shall be used. Wood posts shall have minimum dimensions of 2 inches by 2 inches by 3 feet minimum length, and shall be free of defects such as knots, splits, or gouges.

Steel posts shall consist of either size No. 6 rebar or larger, ASTM A 120 steel pipe with a minimum diameter of 1-inch, U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft. or other steel posts having equivalent strength and bending resistance to the post sizes listed. The spacing of the support posts shall be a maximum of 6 feet.

Fence back-up support, if used, shall consist of steel wire with a maximum mesh spacing of 2 inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to ultraviolet radiation as the geotextile it supports.

Maintenance Standards

- Any damage shall be repaired immediately.
- If concentrated flows are evident uphill of the fence, they must be intercepted and conveyed to a sediment pond or other suitable control.
- It is important to check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment.
- Sediment deposits shall either be removed when the deposit reaches approximately one-third the height of the silt fence, or a second silt fence shall be installed.
- If the filter fabric (geotextile) has deteriorated due to ultraviolet breakdown, it shall be replaced.



Silt Fence

Geotextile Standards	
Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film wovens (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

BMP C241: TEMPORARY SEDIMENT POND

Purpose

Sediment ponds remove sediment from runoff originating from disturbed areas of the site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

Conditions of Use

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or other appropriate sediment removal best management practice.

A sediment pond shall be used where the contributing drainage area is 3 acres or more and where a permanent pond is designed. Ponds must be used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin.

Design and Installation Specifications

- Sediment basins must be installed only on sites where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is required, the type of fence and its location shall be shown on the ESC plan.

- Use of infiltration facilities for sedimentation basins during construction tends to clog the soils and reduce their capacity to infiltrate. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum of 2 feet above final grade. Final grading and placement of the gravel envelope of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized and all upstream BMP's are in place. The infiltration pretreatment facility should be fully constructed and used with the sedimentation basin to help prevent clogging.

- The most common structural failure of sedimentation basins is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and, (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support.

The most critical construction sequences to prevent piping will be:

1. Tight connections between pipe connections.

2. Proper soil compaction of the embankment and piping.

3. Proper construction of anti-seep devices, if required.

Maintenance Standards

- Sediment shall be removed from the pond when it reaches 1–foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

BMP C252: BMP MAINTENANCE

Purpose

Proper maintenance must be ongoing to ensure that the implemented BMP's are functioning as intended. Maintenance is to be performed on both a routine and corrective basis as the situation dictates.

Maintenance includes the following tasks:

1. Inspection of facilities for proper placement or damage.

2. Repair/replacement of facilities as necessary.

3. Removal of sediment or deposits to promote the effectiveness of the facilities.

Conditions of Use

Maintenance must be ongoing in order to maintain the effectiveness of the BMPs. Prioritize maintenance by areas with the highest potential for pollutant loading or discharge.

Design and Installation Specifications

- Remove sediments after sufficient accumulation has occurred.

- Periodically clean accumulated silt and sediment from catch basins, inlet boxes and retention basins. Particular attention should be given to removal prior to wet seasons.

- Maintain vegetation in basins so as to not interfere with the function of the facility.

Maintenance Standards

- Routine inspection and maintenance, particularly following significant storm events, must be done to ensure proper operations of facilities.

- Keep accurate logs of maintenance activities.

BMP C254: STRAW WATTLE

Purpose

Straw wattles are temporary erosion and sediment control barriers consisting of straw that is wrapped in biodegradable tubular plastic or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and capture and retain sediment. Straw wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length. The wattles are placed in shallow trenches and placed with stakes, rebar, or sand bags along the contour of disturbed or newly constructed slopes or at the base of concrete or asphalt surfaces.

Conditions of Use

- Disturbed areas that require immediate erosion protection.
- Exposed soils or hard surfaces during the period of short construction delays, or over winter months.
- On slopes requiring stabilization until permanent vegetation can be established.
- Straw wattles are effective for one to two seasons.
- If conditions are appropriate, wattles can be staked to the ground using willow cuttings for added revegetation.
- Rilling can occur beneath wattles if not properly entrenched and water can pass between wattles if not tightly abutted together.

Design and Installation Specifications

- It is critical that wattles are installed perpendicular to the flow direction and parallel to the slope contour.
- Narrow trenches should be dug across the slope of contour to a depth of 3 to 5 inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches should be dug to a depth of 5 to 7 inches, or ½ to ⅔ of the thickness of the wattle. On asphalt or concrete surfaces, wattles should be placed at the base of the slope with compacted soil on the upslope side. Sandbags should be used when wattles are placed on concrete, asphalt, or other hard surfaces.
- Start building trenches and installing wattles from the base of the slope and work up. Excavated material should be spread evenly along the uphill slope and compacted using hand tamping or other methods.

- Construct trenches at contour intervals of 3 to 30 feet apart depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches.

- Install the wattles snugly into the trenches and abut tightly end to end. Do not overlap the ends.

- Install stakes, rebar, or sandbags at each end of the wattle, and at a minimum 4-foot centers along entire length of wattle.

- If necessary, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.

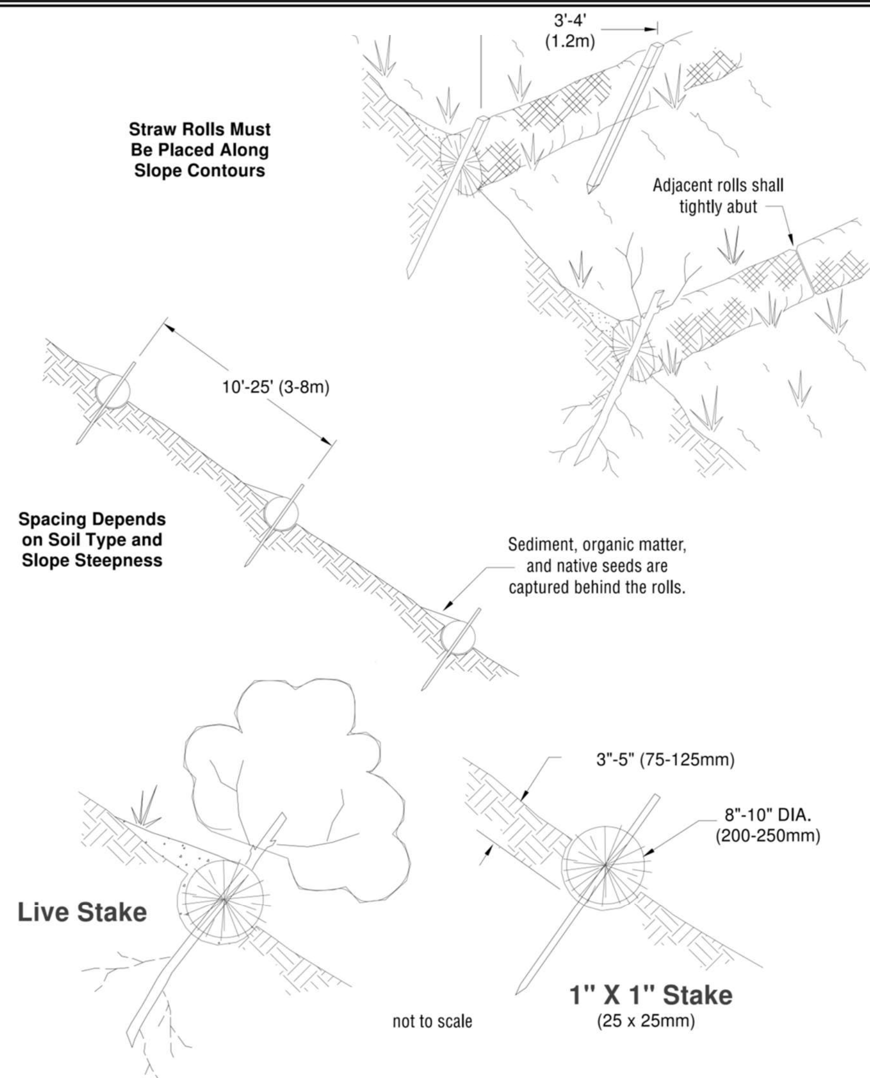
- At a minimum, wooden stakes should be approximately ¾ x ¾ x 24 inches. Willow cuttings or $^{3}/_{8}$-inch rebar can also be used for stakes.

Maintenance Standards

- Stakes or rebar should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake or rebar protruding above the wattle.

- Wattles may require maintenance to ensure they are in contact with soil or surface and thoroughly entrenched, especially after significant rainfall on steep sandy soils.

- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles.



NOTE:
1. Straw roll installation requires the placement and secure staking of the roll in a trench, 3"-5" (75-125mm) deep, dug on contour. runoff must not be allowed to run under or around roll.

Appendix I: Construction General Permit

If all storm water team members access the CGP via the internet while on site the following link to access the Construction General Permit is sufficient:

http://construction.stormwater.utah.gov

Otherwise, include a printed out copy of the Construction General Permit in this appendix.