# 5. IMPLICATIONS FOR MIXED-USE BUILDINGS

The GCCDS worked with the BHA to identify a prospective site and program for the development of a sample mixed-use building in Biloxi, Mississippi. Using this identified site and program, the GCCDS designed a sample mixed-use building to fit the parameters of the site, taking into consideration zoning, parking, landscaping, and massing within the neighborhood context. The building was designed to meet the City of Biloxi floodplain management ordinance, along with applicable building code requirements. The process of designing a sample building was used to integrate knowledge gained from earlier research presented in Chapters Two, Three, and Four of this report, regarding regulatory and technical feasibility of dry floodproof construction. Additionally, the process of designing a sample building provided further research of the economic and insurance implications of dry floodproof construction, in areas such as construction methods, cost premiums, insurance coverage and building operations.

## 5.1 Mixed-Use Buildings

The sample building demonstrates a conventional mixed-use building arrangement with accessible commercial units located on the lowest ground level and residential units located above on the upper floors. The combination of residential and commercial units within the same building creates an opportunity for the developer to offset the added costs of dry floodproof commercial construction by providing supplemental income through the sale or rental of the residential units, which may have lower construction costs (per square foot) than the premium costs for commercial units located within the flood plain. In this design each use (commercial and residential) was given its own entrance to allow the design team to investigate the urban design challenges of integrating a multiple entry dry floodproof building into an existing commercial corridor.

## 5.2 Site Considerations

The site chosen for the sample mixed-use building is located on Division Street in East Biloxi and was selected for a number of reasons:

a) The site lends itself well to the integration of dry floodproofing with a grade-and-fill strategy to meet the BFE requirements (See Fig. 5.1)
b) The location of the site is within an existing commercial corridor that has been targeted for redevelopment. A mixed-use building would serve as much needed infill development along Division Street.
c) The site is already zoned for both commercial and residential use.
d) The site is large enough to accommodate a building to include dry floodproofing and elevation mitigation strategies, as well as accessible elevated walkways (see Chapter 3.2.2- Combining Flood Risk Mitigation Strategies).

e) The site is currently owned by the BHA, which acts as both a property manager and a developer. The collaboration between the GCCDS and the BHA draws on both agencies' existing partnerships to bring many parties into the conversation surrounding the design and economic feasibility of dry floodproof buildings.

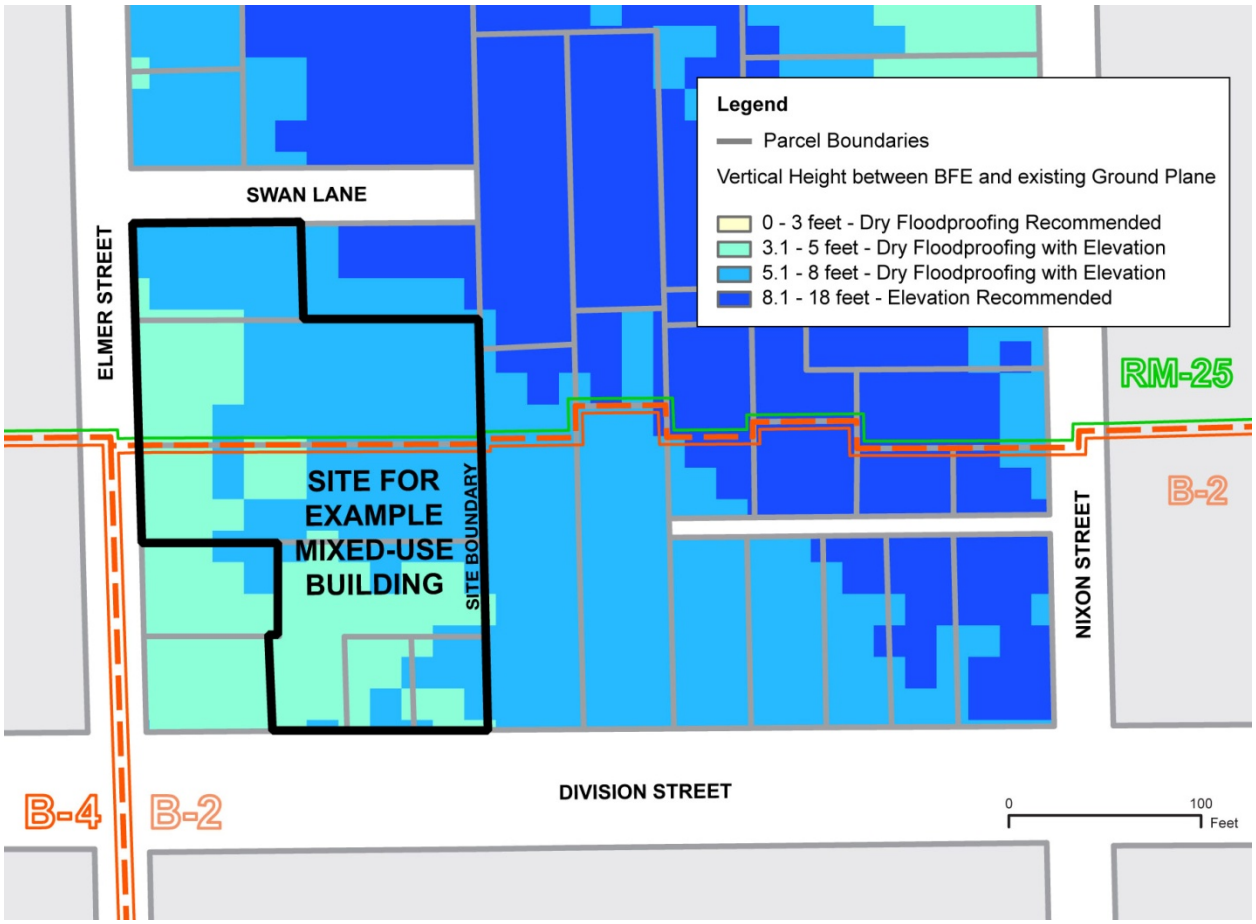


**Fig. 5.1. DIAGRAM: Map of sample site with recommended mitigation strategies.**

The site plan for the sample mixed-use building (Fig. 5.2) focuses on integrating the street level with all entrances to the building. An at-grade walkway allows for access through the site, connecting the rear parking to the commercial and residential entrances. Residents have a separate entrance from the commercial spaces to make it easier to secure the separate sections of the building during different times of day and night. A special hazard egress was combined with the service entrance in the back of the commercial space to allow emergency exit from the building above the extent of dry floodproofing.

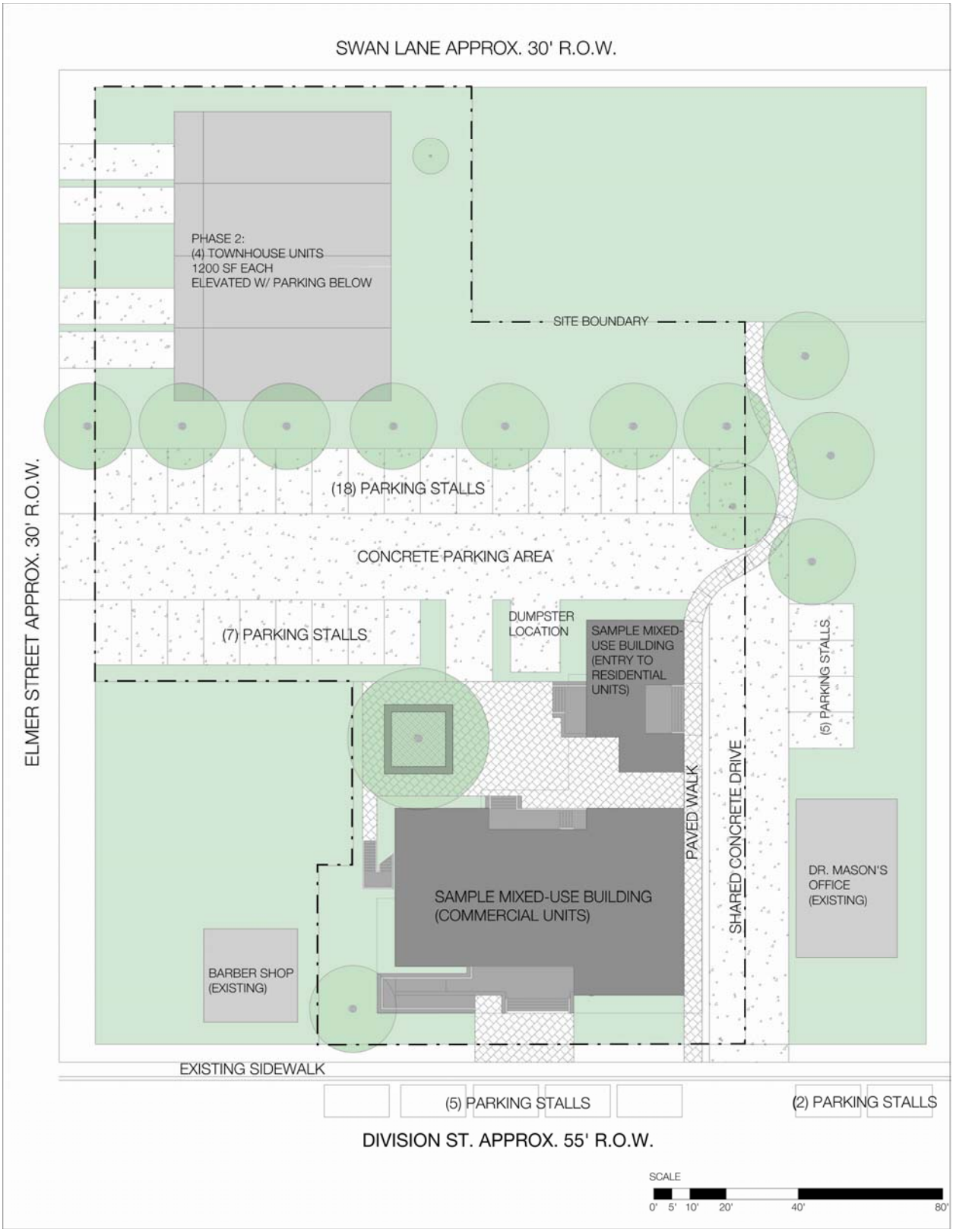


**Fig. 5.2. DIAGRAM: Site plan for sample building.**

## 5.3 Programming

**Table 3. Building program**

| Division Street Floodproof Construction Mixed-Use Building | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| First Floor [Commercial]: 4417 sf | area (sf) | quantity | total area | | First Floor [Res. Amenities]: 1182 sf | area (sf) | quantity | total area |
| Commercial A | 744 | 1 | 744 | | Stairwell | 164 | 1 | 164 |
| Commercial B | 542 | 1 | 542 | | Elevator | 39 | 1 | 39 |
| Commercial C | 871 | 1 | 871 | | Lobby | 125 | 1 | 125 |
| Storage A | 129 | 1 | 129 | | Office | 145 | 1 | 145 |
| Storage B | 112 | 1 | 112 | | Laundry | 167 | 1 | 167 |
| Storage C | 198 | 1 | 198 | | Restroom | 40 | 1 | 40 |
| Restrooms | 74 | 2 | 148 | | Corridor | 39 | 1 | 39 |
| Corridor | 193 | 1 | 193 | | Exterior Entrys | 131-143 | 2 | 274 |
| Exterior Entry North | 620 | 1 | 620 | | | | | |
| Exterior Entry South | 195 | 1 | 195 | | | | | |
| Mechanical Room | 245 | 1 | 245 | | | | | |
| | | *program area* | *3997* | | | | *program area* | *993* |
| | | | | | | | | |
| Second Floor [Residential]: 5700 sf | area (sf) | quantity | total area | | Third Floor [Residential]: 5700 sf | area (sf) | quantity | total area |
| Stairwells/Lobby | 379 | 2 | 379 | | Stairwells/Lobby | 379 | 2 | 379 |
| Corridor | 465 | 1 | 465 | | Corridor | 465 | 1 | 465 |
| Studios | 269-283 | 5 | 1373 | | Studios | 269-283 | 5 | 1373 |
| 1 Bedrooms | 509-580 | 4 | 2173 | | 1 Bedrooms | 509-580 | 4 | 2173 |
| 2 Bedroom | 696 | 1 | 696 | | 2 Bedroom | 696 | 1 | 696 |
| | | *program area* | *5086* | | | | *program area* | *5086* |
| **Total Floor Area: 17,000 sf** | | | | | | | | |

The sample building is a three-story mixed-use building. The first floor is made up of three similar commercial units (Fig. 5.3). The upper two floors are occupied by a variety of studio, one- and two-bedroom rental units, with a total of 20 residential units. (See Table 3.)

The front entrances for the three commercial units are located on a raised (3' above existing grade) patio with direct access to the sidewalk. Interior back entrances from each commercial unit provide access to a set of shared restrooms, storage closets, and an elevated mechanical room with egress elevated above the extent of dry floodproofing. The FFE of the special hazard egress is required to be above the limit of dry floodproof construction, per dry floodproof regulations stated in ASCE 24 Section 6.2.2. Secured residential entrances along with service spaces for the residential units are located on the first floor, although separated by an outdoor breezeway from the commercial units. The program for residential service area does not include any living spaces; only support spaces such as a shared laundry room, a lobby with mailboxes and a leasing office. (Fig. 5.3)

The upper floors of the building were included in the cost estimates, but the layout and design were not substantially influenced by the inclusion of dry floodproof construction in the design of the lower commercial level. However, the upper floors were designed to accommodate affordable rental units, potentially to meet the needs of elderly tenants. The sizes of the residential units were determined by an existing unmet need within the East Biloxi community for affordable studio and one-bedroom multi-family housing units.

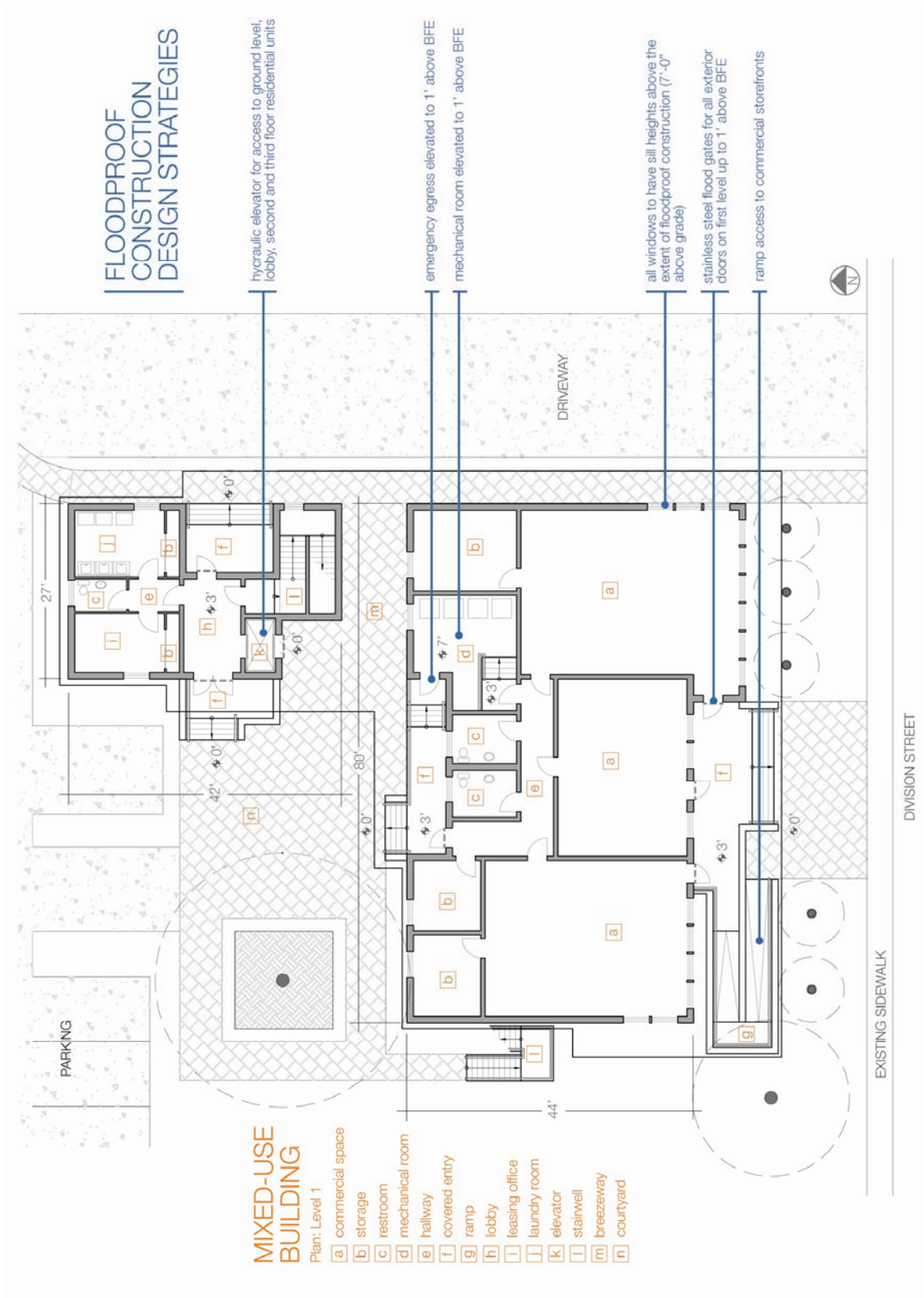


**Fig. 5.3. DIAGRAM: First floor plan for sample building.**


**Fig. 5.4. DIAGRAM: Front (south) and side (east) elevations for sample building.**

## 5.4 Dry Floodproof Construction Details

The construction details designed for the dry floodproof perimeter wall in the sample mixed-use building were determined by synthesizing the demonstrated performances of a variety of test pods observed through the material and assembly research presented in Chapter Four. As shown in Figure 5.4, the dry floodproof perimeter wall extends to 7′ above the existing ground plane, which is 1′ above the BFE. The finished floor of the first level is elevated 3′ above the ground plane on a concrete slab supported by structural fill. (See Fig. 5.5 and Fig. 5.6)

The foundation wall is a reinforced monolithic wall with a continuous footing, protected by a polyethylene vapor barrier. The exterior wall for both the first level and the upper levels is a reinforced CMU block wall. Up to the extent of dry floodproofing, the wall has a multi-layered polymer membrane coating (two layers of silicone modified polyurea sandwiching 2″ of closed-cell spray foam), acting as the waterproofing membrane (as tested with test pod A: sealed block). An air space separates the exterior of this membrane from a brick wall, which is tied back to the CMU wall with truss mesh ties. Similar to test pod B: cavity wall, this wall system has a mortar deflection system and polypropylene weep vents to allow proper drainage at the base of the wall.

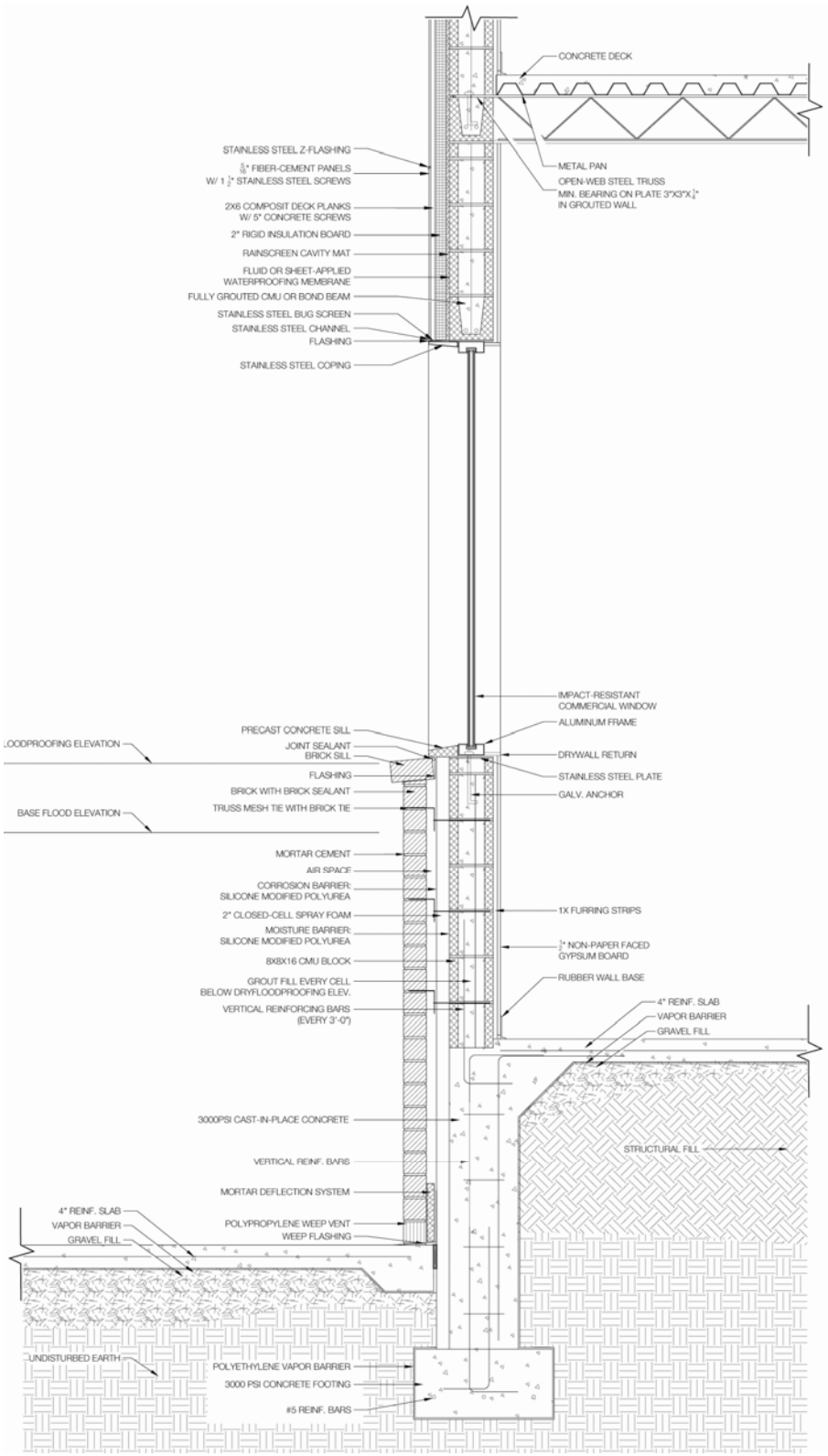


**Fig. 5.5. DIAGRAM: Wall section for sample building.**

## 5.5 Building Cost and Premiums

When building a dry floodproof building, there are certain premiums above those found in typical commercial construction. Some, like the cost of the perimeter floodproof wall are more obvious, but there are other considerations that are both dependent and independent of site choice. Dependent factors to consider include insurance and the cost of grade-and-fill to accomplish the necessary elevation. An example that is independent of site conditions would be the added cost of required egress above the dry floodproof elevation.

**Table 4. Cost Estimate for sample building.**

| Mixed-Use Building Cost Estimate | | | | | | |
|---|---|---|---|---|---|---|
| Name | Base Cost | %Total | Dry Cost | % Total | Total Price | Total % |
| SUBSTRUCTURE | | | | | | |
| Foundation | 87,500 | 14.2% | 30,000 | 4.9% | 117,500 | 19.1% |
| Damproofing/Water Proofing | 10,000 | 1.6% | | | 10,000 | 1.6% |
| Total SUBSTRUCTURE | | | | | | |
| | | | | | | |
| SHELL | | | | | | |
| Superstructure | 300,000 | 48.7% | | | 300,000 | 48.7% |
| Exterior Enclosure: Unsealed Block | 270,000 | 43.8% | | | 270,000 | 43.8% |
| Exterior Enclosure Options: Dry Floodproofing | | | | | | |
| Sealed Block | | | *150,000* | *24.3%* | *150,000* | 24.3% |
| Windows & Doors | 200,000 | 32.4% | | | 200,000 | 32.4% |
| Total SHELL | | | | | | |
| | | | | | | |
| INTERIORS | | | | | | |
| Commercial Interiors | 100,000 | 16.2% | 15,000 | 2.4% | 115,000 | 18.7% |
| Commercial Finishes | 60,000 | 9.7% | 30,000 | 4.9% | 90,000 | 14.6% |
| Residential Interiors | 200,000 | 32.4% | | | 200,000 | 32.4% |
| Residential Finishes | 100,000 | 16.2% | | | 100,000 | 16.2% |
| Total INTERIORS | | | | | | |
| | | | | | | |
| SERVICES | | | | | | |
| Mechanical | 300,000 | 48.7% | 40,000 | 6.5% | 340,000 | 55.2% |
| Electrical | 250,000 | 40.6% | 20,000 | 3.2% | 270,000 | 43.8% |
| Plumbing | 200,000 | 32.4% | 50,000 | 8.1% | 250,000 | 40.6% |
| Fire Alarm & Supression | 30,000 | 4.9% | | | 30,000 | 4.9% |
| Elevator | 100,000 | 16.2% | 30,000 | 4.9% | 130,000 | 21.1% |
| Total INTERIORS | | | | | | |
| | | | | | | |
| EQUIPMENT & FURNISHINGS | | | | | | |
| Equipment & Furnishings | 100,000 | 16.2% | 10,000 | 1.6% | 110,000 | 17.8% |
| Total EQUIPMENT & FURNISHINGS | | | | | | |
| | | | | | | |
| SPECIAL CONSTRUCTION | | | | | | |
| Stairs & Ramps and Exterior Decks | 150,000 | 24.3% | 50,000 | 8.1% | 200,000 | 32.4% |
| Flood Shields | | | 50,000 | 8.1% | 50,000 | 8.1% |
| Total SPECIAL CONSTRUCTION | | | | | | |
| | | | | | | |
| SITEWORK | | | | | | |
| Sitework & Improvements | 75,000 | 12.2% | 75,000 | 12.2% | 150,000 | 24.3% |
| Total SITEWORK | | | | | | |
| | | | | | | |
| PROJECT SUBTOTALS | 2,532,500 | 410.8% | 550,000 | 89.2% | 3,082,500 | 500.0% |
| General Conditions (20%) | 616,500 | | | | 616,500 | |
| | | | | | | |
| | | PROJECT TOTAL | | | $3,699,000 | |

### 5.5.1 Dry Floodproofing Costs

The cost estimate of floodproofing the sample building envelope includes additional costs for both the premium wall materials to be used within the flood plain (such as the multi-layered polymer membrane) and flood shields for exterior door openings located below the BFE. In the sample building design, all windows were placed above the BFE to reduce the need for flood shields over window openings. This sample building has seven doors located below the BFE which would each need a flood shield. The additional cost estimate for building the perimeter wall in the sample building to dry floodproof standards would be $150,000. The additional cost estimate for providing flood shields for the exterior door openings in the sample building would be $50,000.

In Table 4, the total cost of meeting dry floodproof construction standards is estimated to be approximately 15% of the total budget for the project. Table 5 shows the costs of construction using other assemblies which performed well during the flood simulations as the dry floodproofing method for the sample mixed-use building. The average cost of the dry floodproofing components across the various assemblies was approximately $455,000, or 12.75% of the total budget for the project.

**Table 5. Cost Estimates for sample building using alternative construction types.**

| PROJECT TOTALS (Dry Floodproofing Options) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Base Cost | %Total | Dry Cost | % Total | Subtotal Price | General Conditions | % Total |
| Sealed Block | 2,532,500 | 68.5% | 550,000 | 14.9% | 3,082,500 | 616,500 | 20.0% |
| | | | | | | **PROJECT TOTAL** | **$3,699,000** |
| Sheet Membrane Block | 2,532,500 | 71.2% | 430,000 | 12.1% | 2,962,500 | 592,500 | 20.0% |
| | | | | | | **PROJECT TOTAL** | **$3,555,000** |
| ICF | 2,487,500 | 70.9% | 435,250 | 12.4% | 2,922,750 | 584,550 | 20.0% |
| | | | | | | **PROJECT TOTAL** | **$3,507,300** |
| SIP | 2,487,500 | 71.7% | 404,000 | 11.6% | 2,891,500 | 578,300 | 20.0% |
| | | | | | | **PROJECT TOTAL** | **$3,469,800** |

Beyond the cost of construction of a dry floodproof wall system and the cost of installation of flood shields, there are several other cost premiums for bringing the entire building up to dry floodproof standards. The additional requirements discussed in the next sections are based on the City of Biloxi floodplain ordinance and may not be directly applicable in other municipal jurisdictions.

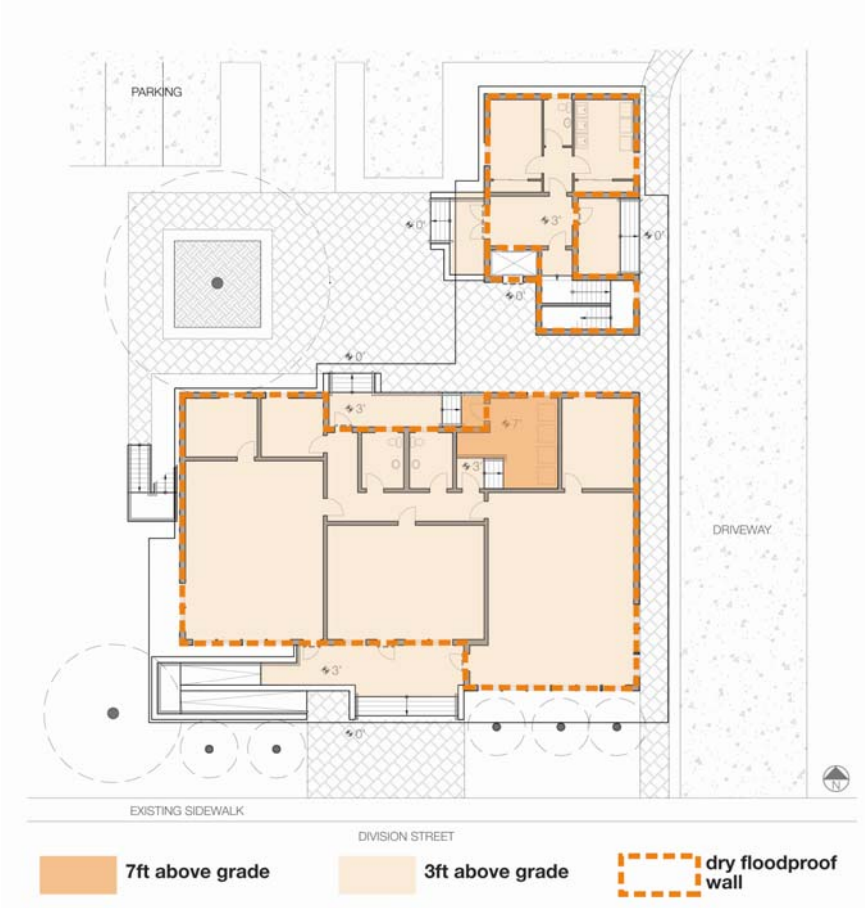


**Fig. 5.6. DIAGRAM: Dry floodproof construction, first floor, sample building.**

### 5.5.2 Grade-and-Fill Costs

A strategy combining dry floodproofing and grade-and-fill methods is used for the sample mixed-use building on the Division Street site (Fig. 5.6). This combination allows the building to meet the City of Biloxi regulation limiting dry floodproofing to 3′ below the BFE on a site that has an existing grade of 6′ below the BFE. The sample mixed-use building designed on this site required three feet of grading and fill, which accounted for approximately $120,000 (nearly three percent) of the total project budget.

### 5.5.3 Utility and Egress Costs

In addition to the increased costs of wall and foundation construction, there are cost premiums associated with the egress and utility requirements of a dry floodproof building. ASCE 24-05, *Flood Resistant Design and Construction* contains standards for the construction of these systems. While these costs are not as significant as those associated with the wall and foundation construction, they are important to be aware of because they do not correspond to the size of the building. These additional premiums would be required in any dry floodproof building, regardless of the size or program.

The ASCE regulations outlined in *Flood Resistant Design and Construction* pertaining to egress and utilities are as follow:

> 7.1: "Utilities and attendant equipment shall not be located below the elevation specified [BFE + 1'] unless...designed, constructed, and installed to prevent floodwaters, including any backflow through the system, from entering or accumulating within the components."
>
> 6.2.2: "Dry floodproofed areas of structures shall...have at least one door satisfying building code requirements for an exit door or primary means of escape, above the applicable elevation specified [BFE + 1'] …and capable of providing human ingress and egress during the design flood."

In the sample mixed-use building, the decision was made to keep utilities and equipment above the BFE. The cost reflected in the estimate includes backflow prevention, which does not add significant cost to the overall system. In order to achieve the elevated egress required, $45,000 was added to the cost estimate.

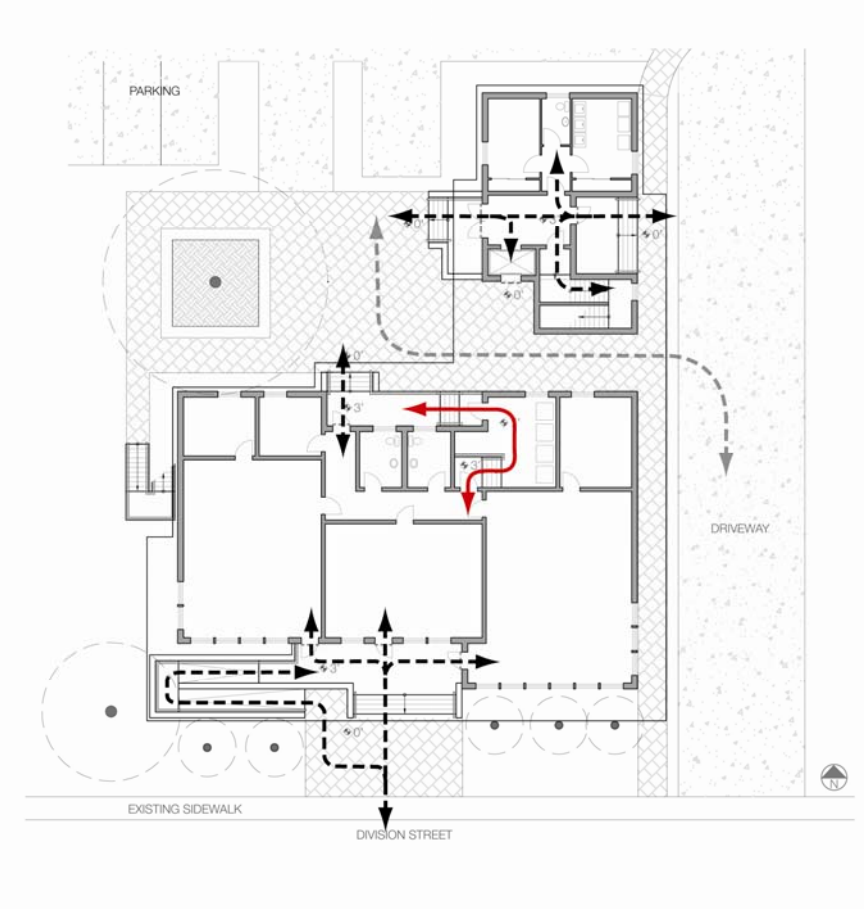


**Fig. 5.7. DIAGRAM: Means of egress with egress above dry floodproof construction (red).**

## 5.6 Insurance Considerations

Flood insurance is a requirement for any building located within a floodplain in a community participating in the NFIP. A certified dry floodproofed building is able to be insured with the same rates as a building built with a finished floor just above the BFE. There are no unique rates or penalties for dry floodproof buildings in comparison to elevated buildings.

### 5.6.1 Insurance Limits

The maximum coverage for a dry floodproofed commercial building insured through the NFIP is $500,000. If a building is worth more than this maximum, many lenders will require the owner to get a secondary insurance policy to cover the difference. Unfortunately, as has been the case during the investigation of potential flood insurance scenarios, learning from local providers along the Mississippi Gulf Coast has been difficult. Local providers are not involved at the level of floodproof construction policy, which is mandated by the NFIP. NFIP "rates are set and do not differ from company to company or agent to agent… [they] depend on several factors including the date and type of construction of your home, along with your area's level of risk" (NFIP, 2011). While a mixed-use development may be profitable, issues of coverage could be an obstacle, as most developments likely are worth more than the $500,000 maximum coverage offered by the NFIP.

### 5.6.2 Beyond Code

A research goal explored through the design of the sample mixed-use building was to find ways to reduce insurance premiums through construction methods which are more robust than those required by code.

One program given consideration was the Insurance Institute for Business & Home Safety's (IBHS) FORTIFIED building program. The program incentivizes building beyond the local code requirements to strengthen the shell of the building "to increase a new home's resistance to natural perils" (IBHS, 2011). Certification in the program is accompanied by a reduction in insurance premiums through wind-pool insurance. Currently the IBHS is expanding beyond their FORTIFIED for Safer Living program which focuses solely on new single-family residential construction to develop a similar program: FORTIFIED for Safer Business.

The aim of the new program is to "greatly increase a new light commercial building's durability and resilience to natural hazards prevalent in the area where it's being built" (IBHS, 2011). Unfortunately, as is the case with other FORTIFIED programs, there is a requirement for the building to be located outside of a flood zone in order to be considered for certification. Due to this restriction, the sample mixed-use building was designed to similar standards, as outlined in the FORTIFIED for Safer Living program, but would not qualify for certification or receive any wind-pool insurance reductions.