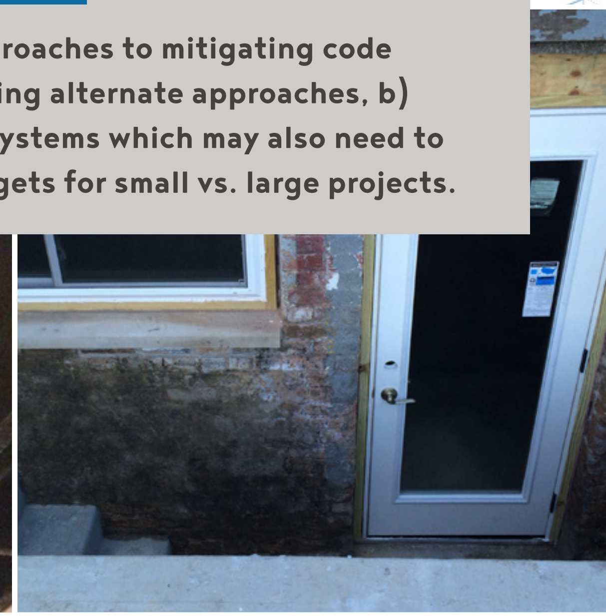
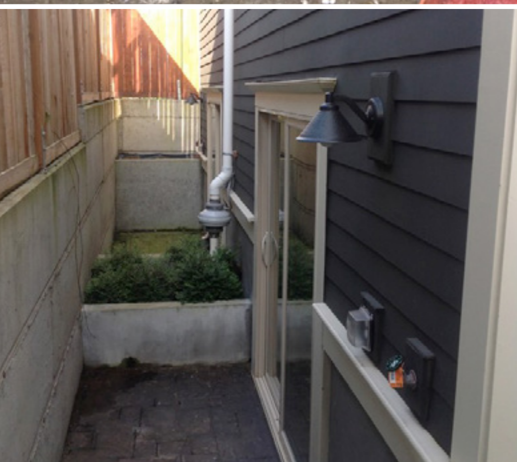
MITIGATING ISSUES . construction options

Addressing Code and Construction Issues:
Principles and Approaches to Constructing Safe Basement Units

INTRODUCTION . compliance issues . mitigation approaches

Mirroring the compliance checklist, this chapter outlines different approaches to mitigating code issues and creating safe units, identifying a) the circumstances dictating alternate approaches, b) typical renovation or repair budgets, and c) interdependent building systems which may also need to be addressed. The final section outlines conversion scenarios and budgets for small vs. large projects.



CHAPTER CONTENTS:

This 'Mitigating Issues' chapter helps you identify, in broad terms, the applicable approach and estimated costs involved in fixing any building element or system that is not code compliant. For every code element introduced in the 'Code Compliant Units' chapter there are one or more sections that outline the contextual variables–site soils, property offsets, existing infrastructure–that will drive your architect's or engineer's recommendations for repair and the estimated cost of your basement conversion.

Each mitigation section includes the follow :

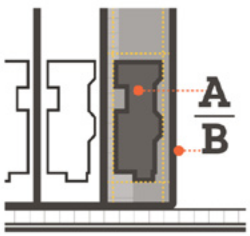
- **Thumbnails for Visual Identification:** These photos show existing elements, common tests, and construction in process. They are spread between the introductory identification and specific fixes, to enable you to visually inspect ongoing work.
- **Decision Diagrams**: Each section begins with text and a flowchart that identifies the key information which will inform your decisions facing compliance. Sometimes the factors are spatial –like offsets and their impact on drainage and fire resistance. Some are derived from specific testing; soils, air changes, radon levels. Sometimes decisions will hinge on engineering assessments or personal preferences. The more you understand the decision factors, the more you can engage with your architect or engineer and their guidance during the design process.
- **Additional elements for coordination**: For each alternate approach to mitigation shown, a series of bullet points list the physical elements which will require coordinated planning and execution.
- **Alternate approaches**: The second half of each section shows the most common approaches to correcting tissues. These drawings are fairly generic basement sections. Your basement will vary by starting foundation materials, elevation, etc. The sections, diagrams, and cost ranges are provided to give you a general sense of the layered construction systems; the construction documents provided by your architect will be tailored to your basement's circumstances. These details are provided to 1) help you navigate those ultimate drawings and 2) allow for rough cost estimation. **Interventions that are particularly risky and expensive–and thus not advised–are marked with the icon at left.** *These approaches are not listed in the generic estimate tables, specifically because of their overwhelming risk. They may be necessary for structural stability, instead of conversion.*
- ***NHS makes no guarantee as to details' completeness (they are simplified representations when compared with CDs and specs). Given site and conditions variability, NHS cannot guarantee that your basement mitigation directly aligns with the generic systems shown. The drawings are tools for rough estimation and education only.***

In addition to the individual mitigation sections, the chapter ends with two construction scenarios that elaborate on chosen approaches and costs. The first conversion–from a single family Cottage to a Two-Flat–is a larger project due to common revisions to meet code and address structural repairs. The second conversion–from a Two-Flat to a Three-Flat–is a smaller project, with fewer major interventions. For each scenario, an introduction and table outline the assumed conditions and costs. On the following pages a composite decision diagram highlights the contextual decisions behind the project as a whole.

To navigate the larger chapter turn to the next page, 126. The diagram outlines the alliance between code compliance issues and mitigation sections.

CODE COMPLIANCE

issues to correct



ZONING

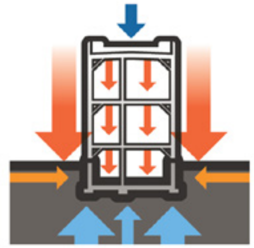
See permits, next chapter.

MAINTENANCE

Q1 CONSTRUCTION PREPARATION: deconversion, demolition & safety concerns

pg 128-131

Overlaps with all others.



STRUCTURE

(LOADING, FOUNDATIONS)

Q2 STRUCTURAL CONCERNS: joist, beam, & foundation repairs

pg 132-135

Foundation repairs and column replacements should be coordinated with slab work, vapor and waterproofing.

Joists and beam updates should be coordination with overhead plumbing, ventiliation, and fire-resistant ceiling finishing.

WATERPROOF

(SLABS)

Q4 AREA DRAINAGE: water & dampproofing assemblies + site drainage

pg 140-143

Slab, vapor and moisture barrier and drainage should be coordinated with any height excavations, utility connections, and required radon exhaust systems.

UTILITIES

Q6 SEWER, WATER CONNECTION: service lines, meters, backflow protection, ejector pumps

pg 148-151

+

Q7 ELECTRIC, GAS CONNECTION: public lines, electric age, heating options, meters

pg 152-155

Utility work should be coordinated with slab work and pipes/conduits should be coordinated with ventilation and finishing.

MITIGATION

factors determining correction approach, alternate typ. fixes (initial elements to address + coordination required; estimates)

line variations for visual clarity only

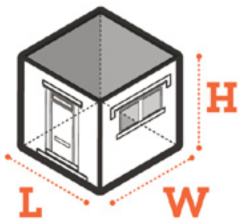
EXAMPLES

COTTAGE CONVERSION
single family to two units (two bedroom unit)

TWO-FLAT CONVERSION
two units to three units (smaller two bedroom unit)

COTTAGE ADAPTATION ESTIMATE
steps, choices, cost range
pg 164-167

TWO-FLAT ADAPTATION ESTIMATE
steps, choices, cost range
pg 168-171



UNIT SIZE
(HEIGHT, AREA)

AIR & LIGHT

EGRESS
(FIRE EXITS)

FIRE SAFEY
(MATERIALS,MONITORS)

Q3 BASEMENT HEIGHT:
excavation, slab structure

pg 136-139

All slab and excavation-based height additions should address issues under waterproofing, radon, and revised utility connections.

Low profile finishes should be coordinated with ventilation & finishing.

Q8 OPENINGS & EGRESS:
windows, doors, exit structure

pg 156-159

+

Q5 AIR SAFETY:
randon exhaust systems
overall ventilation & fans

pg 144-147

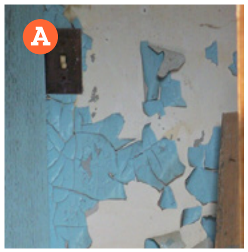
All new openings should be coordinated with structure, vapor & moisture barriers, and comply with external opening allowances based on site-offsets (fire safety).

Q9 FIRE RESISTANCE FINISHING:
ceiling, wall materials

pg 160-163

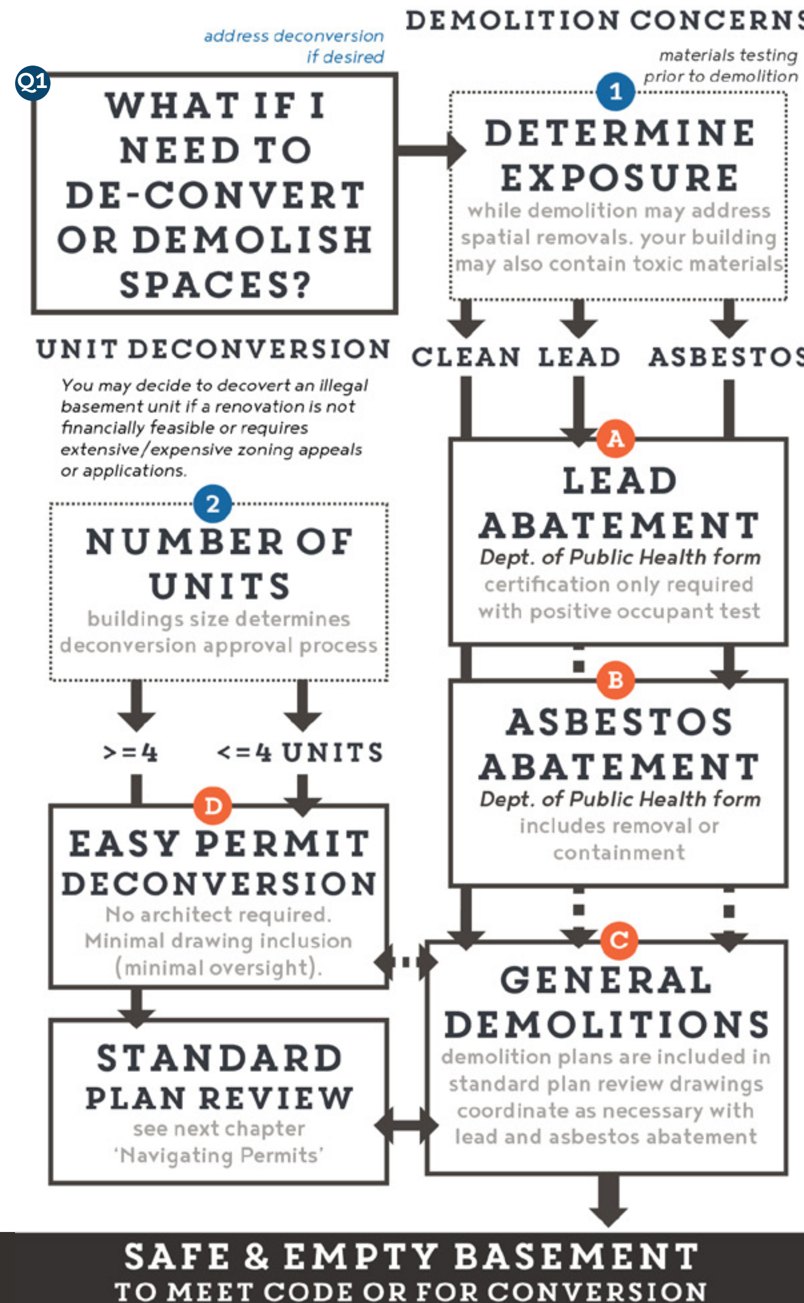
Fire resistance of partitions depends on site offsets and egress routes. Materials should coordinate with ventilation, electric, and plumbing at foundation walls and between overhead beams and joists.

PREPARATION . safe construction



Reference: Issues identified

- **A** older white lead paint, pre-1978
- **A** pealing interior paint-dangerous for creating ingestible/breathable lead particles
- **B** old asbestos wrapped pipes (steam heating system)
- **B** asbestos in loose vermiculite insulation (more common in attics)



CONSTRUCTION PREPARATION:

If you are considering a basement conversion or are looking to de-convert a current illegal unit, you may be facing interior demolition of older interior partitions and indeterminate finishes. For the safety of your family, tenants, and the contractors' crew, you should have material samples tested to determine what environmental cleanup is needed. Environmental permits are submitted after your building or deconversion permits, but for safety, tenant communication, and coordination purposes it's best to assess any toxins and risks early.

Exposure: To detect lead, you can start with a simple home kit, like 3m leadcheck swabs, and follow up with formal lead paint inspection (with paint test and XRF scanning) by a state-licensed lead inspector. For asbestos, all testing should be handled by a professional. If lead is found, your contractor should follow clean-up procedures recommended by the EPA, to avoid tenant exposure. If a child/tenant tests positive for lead, you would be required to submit a Lead-Based Paint Renovation, Repair, and Painting form (LRRP) to the Department of Public Health. If asbestos is present and friable (crumbling) a professional should perform asbestos abatement,coordinated with the city by submitting the "National Emission Standards for Hazardous Air Pollutants" (NESHAP) form.

Deconversion & Demolition: If you have decided not to convert an old, illegal unit, into a legal dwelling, you will need to apply for unit deconversion with the Department of Buildings. The complexity of this depends on your building size: five or six unit buildings must submit deconversion through the Standard Plan eview (see 'Navigating Permits'). Broadly, a standard plan set includes demolition plans–what to keep, what to eliminate–for existing structures; the easy permit requires a very simplified schematic version of that information.

MITIGATION COORDINATION:

A. SAFETY: LEAD PAINT REMOVAL

Lead paint is common in older buildings. Lead particulate and paint chips, if ingested by children, cause lead poisoning and developmental damage. Lead is typically either covered and contained –away from accessible surfaces– or removed during demolition to avoid future hazards. (Learn more at EPA: www.epa.gov/lead and the Department of Public Health: bit.ly/Chicago-Lead .)

Related construction required:

- cleaning is done in tandem with preparatory demolition
- city certification is only required if occupants test positive, but federal safety protocols should guide cover/cleaning practices

B. SAFETY: ASBESTOS REMOVAL

Asbestos was once a common insulating material and may be found wrapping old pipes or in floor and sheathing materials. When airborne it can be inhaled and causes lung cancer. As with lead, intact asbestos can be covered and contained. If crumbling, it should be removed during renovations to lessen the risk of accidental disturbance and fiber release.(Get NESHAP forms at: bit.ly/Chicago-NESHAP)

Related construction required:

- cleaning is done in tandem with preparatory demolition

C. DEMOLITION

General demolition is done at the start of construction or phased by building system to align with repairs and replacements.

Related construction required:

- Architect and contractor will coordinate this larger process and incorporate environmental hazards removals as necessary
- For demolition, under an Easy Permit Deconversion, your contractor should coordinate the required work

D.UNIT DECONVERSION

Deconversion enables a building owner to avoid future zoning violations and fines, when an illegal unit is unable to be converted.

Related construction required:

- not all unit elements need to be removed–Walls can stay and bathrooms are permitted (without full tub or shower).

A. SAFETY: LEAD PAINT REMOVAL

COST VARIES BY EXTENT

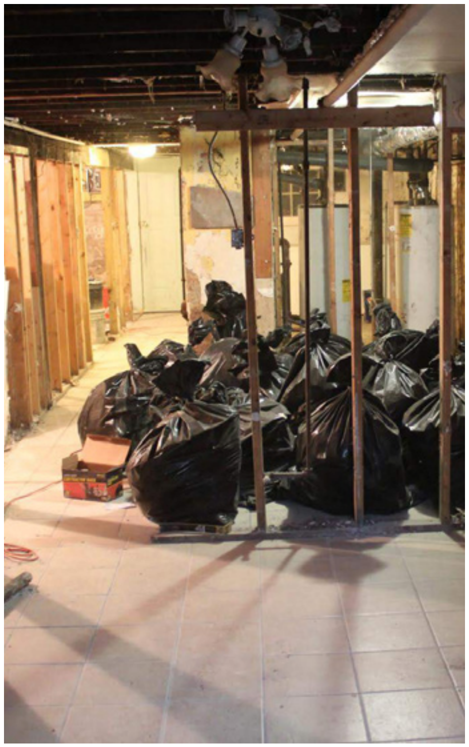
Properly done lead abatement is easy to recognize as it requires the use of plastic tarp for containment, ventilator masks for work safety. and vacuums to remove dusty, contaminated air. Testing is typically inexpensive (under $500) but abatement costs will depend on the extent and complexity of the area. LRRP certification is required if a building occupant test positive & work includes window replacement, work that disturbs 6 square feet + of interior paint or 20 square feet + of exterior paint.

B. SAFETY: ASBESTOS REMOVAL

$300 permit costs COST VARIES BY EXTENT

Asbestos abatement looks similar to lead–with ventilators, plastic containment bags, and air tubes–as removal protocols seek to contain dust and stop particulate dispersal. Testing is reasonable (under $250-$750) but abatement costs will depend on the extent and complexity of the area. Removals tend to be more focused, on specific pipes or insulation, in contrast with the wider area attention required for lead paint abatement.

C. INTERIOR DEMOLITION

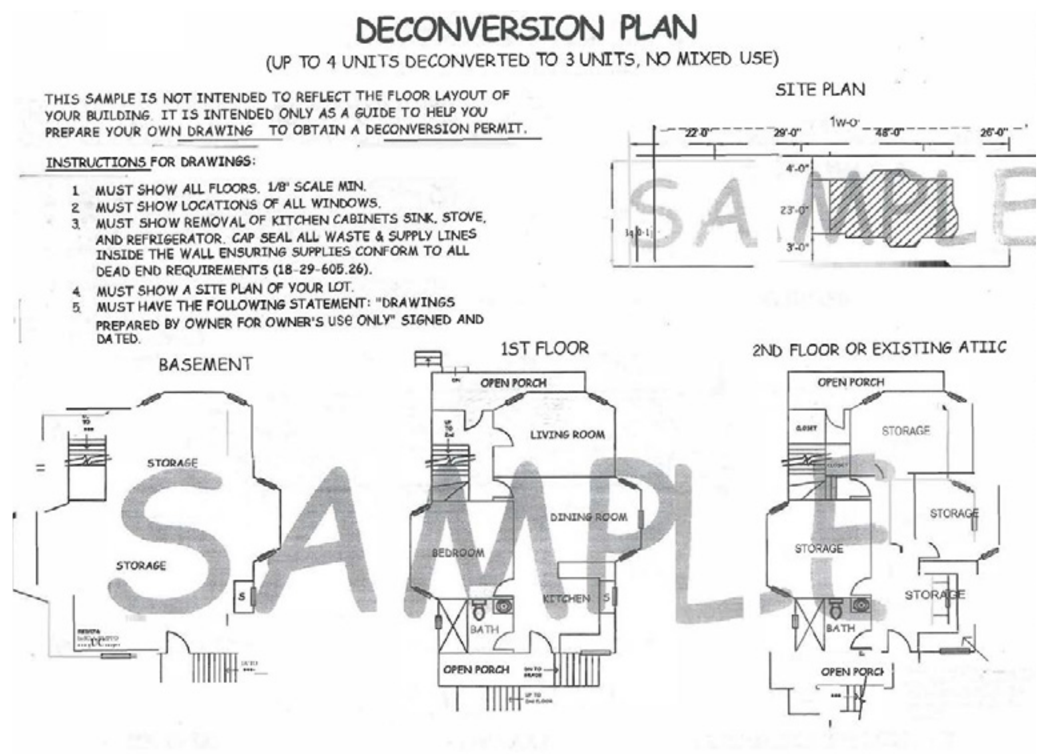


$200-$550 **minor removals, single element or area**

$2,500-$4,000 **old partitions and extensive areas**

General demolition, esp. for deconversion or an empty basement, can be minimal (cabinet removals and capping plumbing). For larger projects, your contractor should coordinate 1) disposal needs, 2) any specific abatement protocols (left), and 3) the temporary structures or transitional services required during demolition and construction. The site should be regularly cleaned to limit fire hazards and nuisance dust. Costs vary by extent.

D. UNIT DECONVERSION



DECONVERSION PLAN

(UP TO 4 UNITS DECONVERTED TO 3 UNITS, NO MIXED USE)

THIS SAMPLE IS NOT INTENDED TO REFLECT THE FLOOR LAYOUT OF YOUR BUILDING. IT IS INTENDED ONLY AS A GUIDE TO HELP YOU PREPARE YOUR OWN DRAWING TO OBTAIN A DECONVERSION PERMIT.

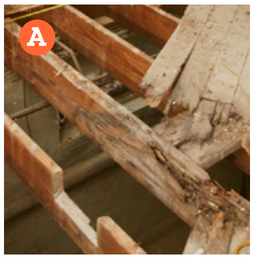
INSTRUCTIONS FOR DRAWINGS:

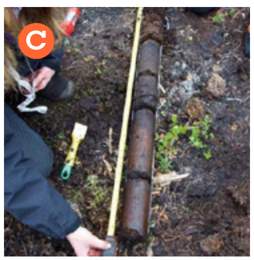
1. MUST SHOW ALL FLOORS. 1/8" SCALE MIN.
2. MUST SHOW LOCATIONS OF ALL WINDOWS.
3. MUST SHOW REMOVAL OF KITCHEN CABINETS SINK, STOVE, AND REFRIGERATOR. CAP SEAL ALL WASTE & SUPPLY LINES INSIDE THE WALL ENSURING SUPPLIES CONFORM TO ALL DEAD END REQUIREMENTS (18-29-605.26).
4. MUST SHOW A SITE PLAN OF YOUR LOT.
5. MUST HAVE THE FOLLOWING STATEMENT: "DRAWINGS PREPARED BY OWNER FOR OWNER'S USE ONLY" SIGNED AND DATED.

$750 **permit via standard plan review (does not include demolition)**

Deconversion permits are fairly inexpensive and, for small buildings, do not require the same planning resources as a conversion. The schematic shown above is provided by the city, to show and list the typical level of detail required (for four or fewer units total, pre-deconversion). Given the site drawings and notes done for the 'Code Compliance' assessments, you could certainly make similar plans. Note that in this sample, attic deconversion simply requires kitchen & plumbing removal, without complex structural/room alterations.

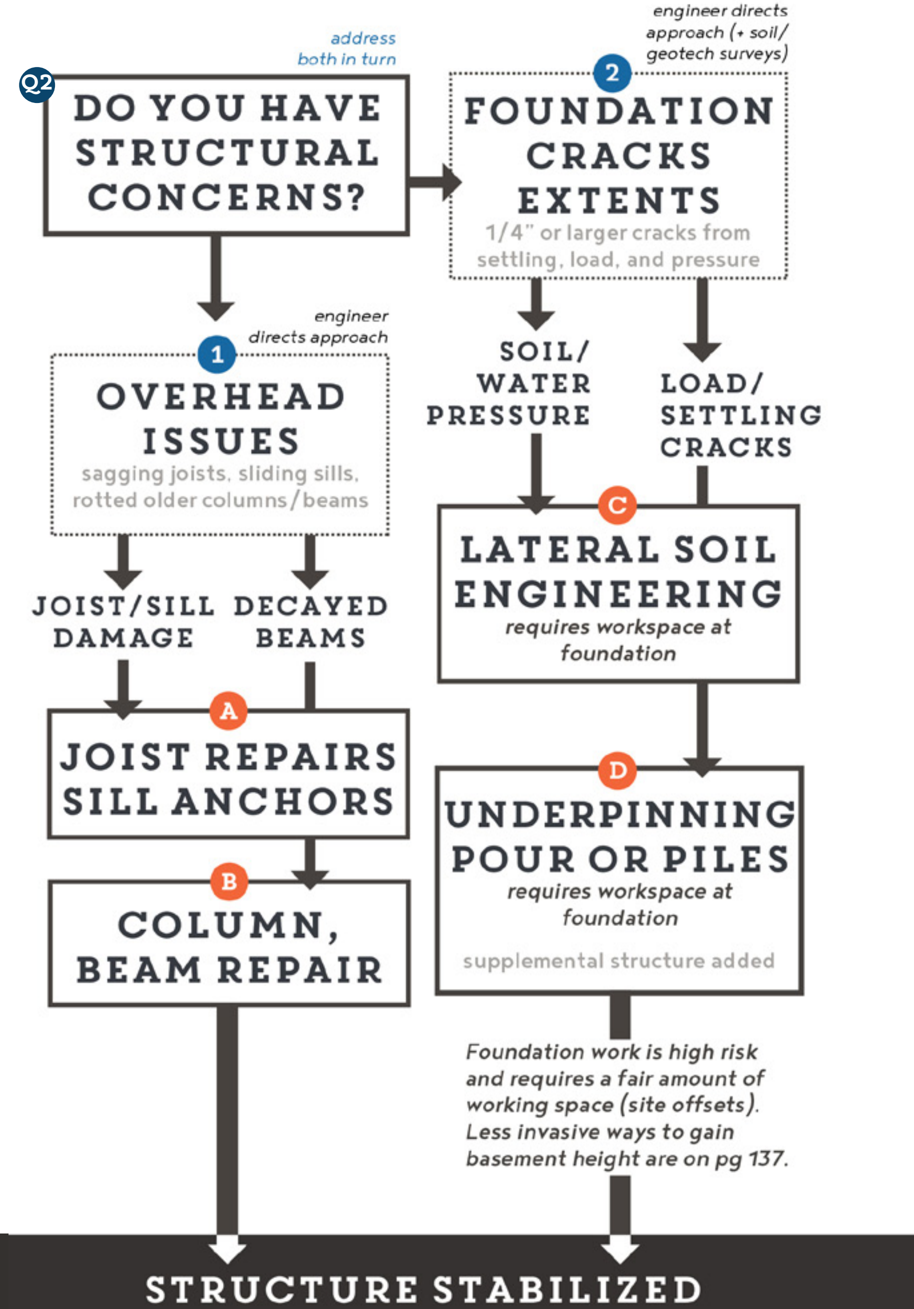
STRUCTURAL ISSUES . existing





Reference: Issues identified

- **A** joist decay from water damage & termites, cuts for plumbing
- **B** column rotted from moisture (temporary hydraulic jack at base)
- **C** bowing & spider cracks indicating soil/water pressure on foundation
- **C** soil cores from site, to determine sources of foundation pressure
- **D** settling addressed by underpinning with helical screws anchored to footer
- **D** settling addressed by underpinning (in sections) with mass concrete pours (adds height, but is high risk)



STRUCTURAL REPAIR APPROACHES:

If you have structural failures or damage in your basement ceiling or your foundation walls, your architect or structural engineer will assess the issues and direct mitigation.

For overhead areas: visual assessment, material samples, and deflection measurements will guide your architect or engineer's recommendations for ceiling joists, sill anchors, and the beam and column system. You may need to remove existing floorboards or plaster to assess the extent and repair approaches. In addition to some of the typical repair approaches on the next page, you should anticipate adding temporary support structures–braces, jacks, wooden framing–to limit the amount of stress and movement to your overall structure during the repair process.

For foundations: if there are large cracks (>1/4"-1/2") which are growing, your architect or engineer should take soil cores or dig test pits–with visual and material samples–to identify the source of loading issues and recommend drainage, soil engineering, or grading/planting resolution. For lesser cracks, you will likely be instructed to take periodic measurements to assess rate of movement/deterioration. For major settling, your architect or engineer may suggest underpinning, replacing unstable soils with supplemental structure. There are several underpinning approaches, which vary based on your foundation materials and work areas. Your architect and engineer will direct this process as it is high risk; under no circumstances should you attempt 'quick' foundation repairs without professional guidance.

The next column describes the additional factors/elements to be coordinated with particular structural repairs (including design and installation considerations). The following details show typical components and cost ranges,to help you estimate and visually confirm satisfactory repair work.

MITIGATION COORDINATION:

A. JOIST & SILL REPAIRS

Additional joists can be added to shore up floors and address minor loading issues. Sill anchors should be retrofitted on wooden frame buildings to avoid the structure sliding off the foundation.

Related construction required:

- address in tandem with beam & foundation repairs,
- frame out interior stairs, utility, and exhaust openings in tandem
- coordinate with ventilation ducts, new openings (sills/anchors)

B. COLUMN & BEAM REPLACEMENT

Replacing rotten wooden columns/beams with metal elements can both stabilize your building and allow larger open spans.

Related construction required:

- address in tandem with other structural issues
- beam height + ducts must work with fire egress height req.
- coordinate footers (at lowest, sewer line depth) and slab joints

C.LATERAL SOILS ENG. (WALL REPAIR)

Water, root, and excessive soil loading impacts on the foundation should be addressed by fixing the underlying issues and rebuilding damaged areas. This will require space around the foundation for implementation.

Related construction required:

- Remediation should be integrated with drainage, utility work
- All repairs should be careful to brace upper structure and use tie-backs or keep soil at repose during sitework
- Excavation permits req. if within 10' of property line or >12' deep

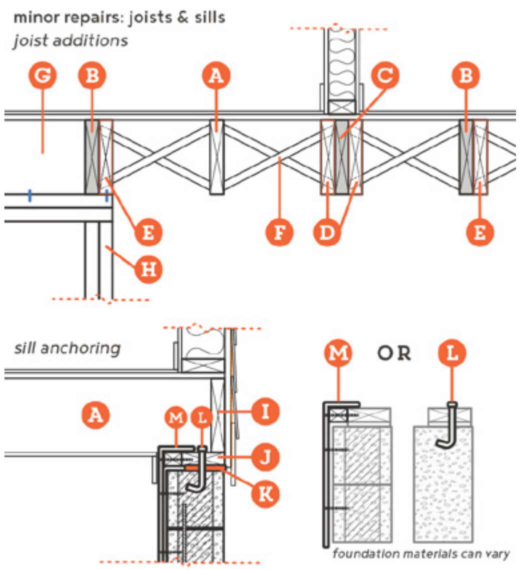
D.UNDERPINNING FOUNDATION

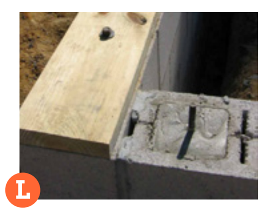
Major settling issues require adding support beneath your footers,to act in place of irregular/moving soils. This is expensive, risky work. If you just need ceiling height, see pg 137.

Related construction required:

- coordinate with drainage, utility, and slab replacement
- movement during underpinning can crack walls and damage upper floors–anticipate extra finishing costs across building
- see repair remark under 'C. Lateral Soils Engineering' above

A. JOIST & SILL REPAIRS



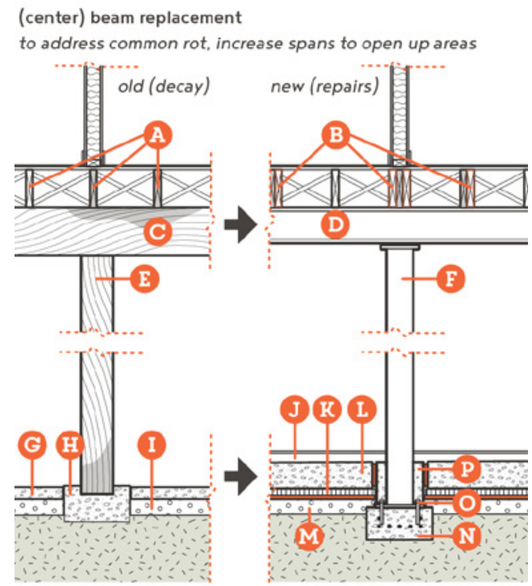


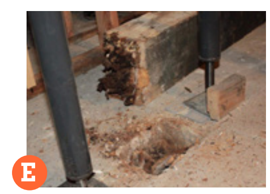
- **A** ok existing joists (depth varies, 16" or 24" o.c.)
- **B** damaged (water, etc.)
- **C** damaged (loads)
- **D** supplemental joist supports under walls
- **E** new joists, bolted laterally
- **F** updated cross-bracing (as necessary)
- **G H** lateral 'blocking' for opening/ new wall frames
- **I** header
- **J** pressure treated sill
- **K** 1/4" foam gasket as moisture barrier to stop water wicking up from foundation
- **L** sill anchor (original) set in grout, concrete, or epoxy
- **M** sill anchor (retrofit) bolted/nailed from side

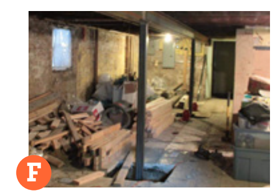
COST VARIES BY EXTENT

Costs vary by damage and design of new openings/wall and loading connections. Sill work should anchor your wooden frame building to its foundation, while stopping water from migrating into the wooden frame. (Sill anchors aren't necessary in stone/brick; your joists may slot into walls without sills/headers. Architect will provide details.)

B. COLUMN & BEAM REPLACEMENT





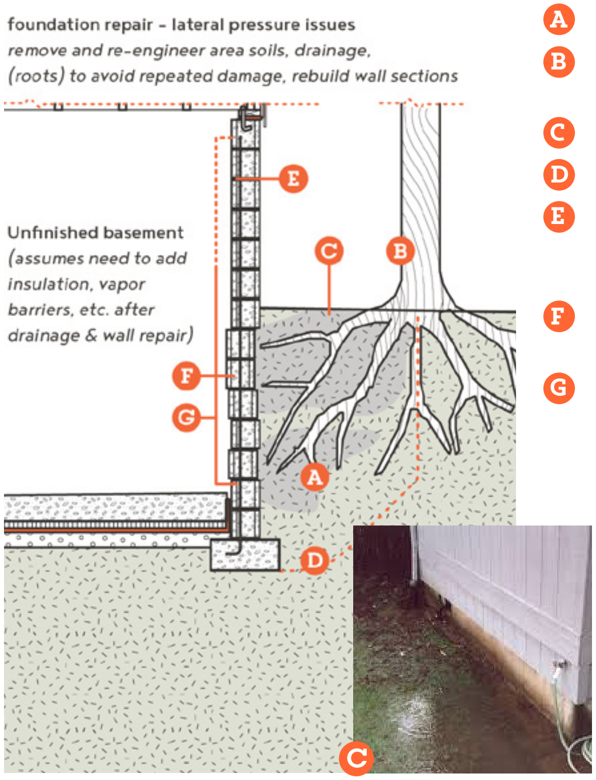


- **A** existing joists
- **B** supplemental joists
- **C** old beam (with rot)
- **D** new i-beam
- **E** old column (base rot)
- **F** new steel column
- **G** slab w/o barriers
- **H** old footer
- **I** old gravel
- **J** finished floor
- **K** continuous moisture/ vapor barriers
- **L** 4" + new slab
- **M** drainage: crushed stone
- **N** new footer
- **O** reinforcement with bolts for column anchoring
- **P** collar with isolation joints at new slab

$3,500-$6,500 (replacement of beam & new columns)

Beam and column replacement should support joists and the structure above, potentially carrying additional loads or spanning additional space between columns. Cost will vary based on materials (number of columns needed, I-beam or timber profiles used) and complexity of your structure (single center beam or multiple bays, each with a beam).

C. LATERAL SOILS ENG., WALL REPAIRS

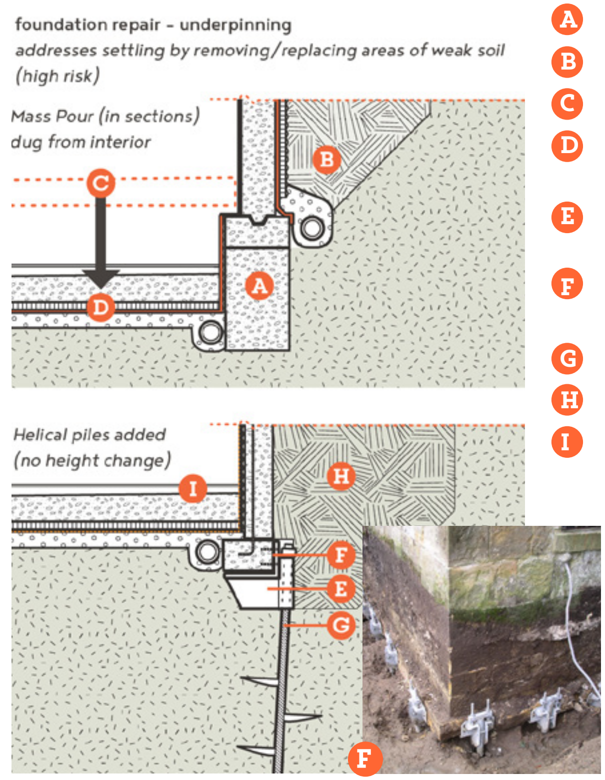


- **A** extra pressure areas
- **B** source of root pressure (following water)
- **C** standing water
- **D** excavation/work area
- **E** mortar decay / lack of grouting can lead to weaker walls
- **F** specific pressure displacements/bowing
- **G** potential repair areas (to be done in sections, with structure braced)

$2,000 soil report, testing **$800-$2,400** roots removal
$4,000-$20,000 wall repairs vary (minor to major)

Repairs and costs will vary by extent. They should address external pressure and internal structure. See drainage for structurally healthy wall sections, pg 141.

D. UNDERPINNING FOUNDATION

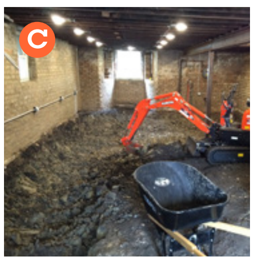


- **A** concrete underpinning
- **B** existing drains (reconnect)
- **C** original slab height
- **D** new slab profile (see interior tile drains)
- **E** beam support under footers
- **F** anchoring to existing footer
- **G** helical piles (to stable soil)
- **H** work area for hydraulics
- **I** no height change for slab

$20,000-$40,000 concrete is less, helical piles more

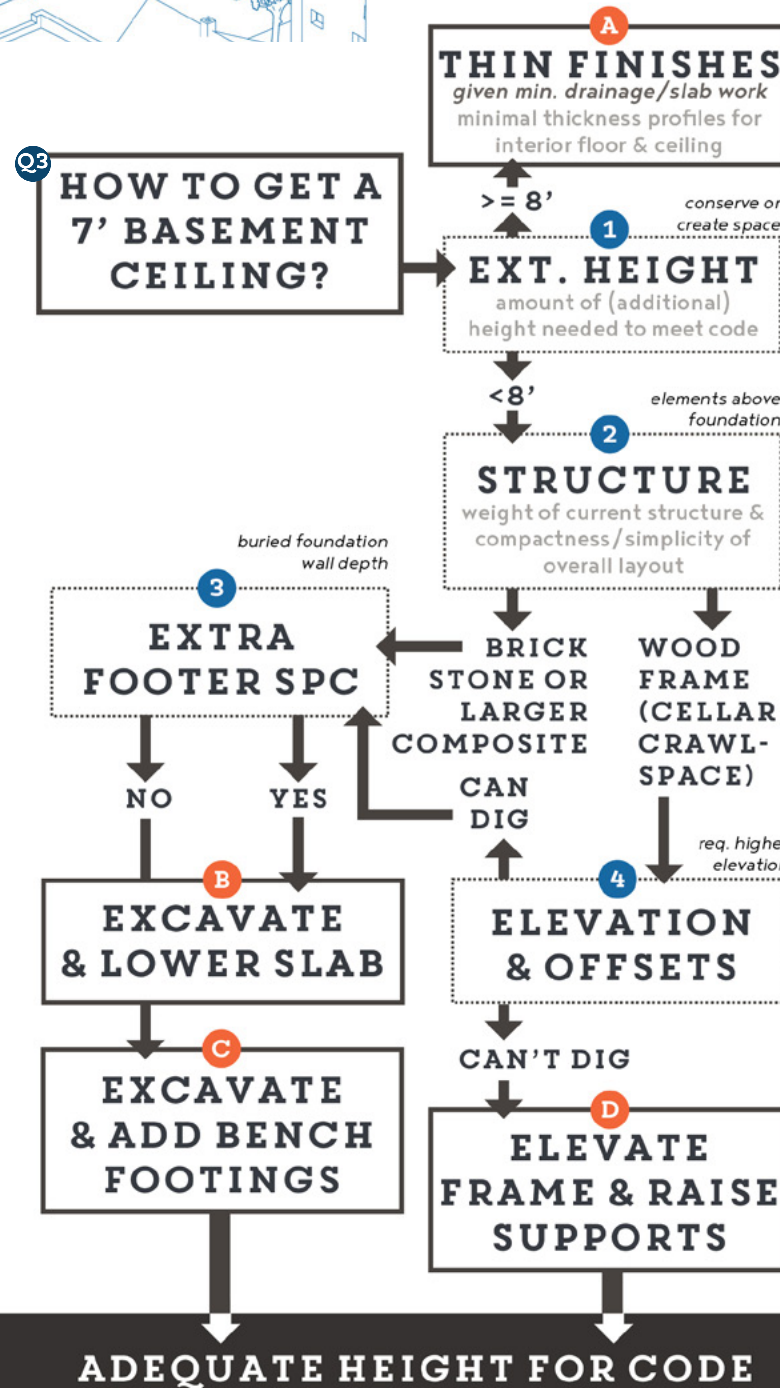
Underpinning should only be done if absolutely necessary to prevent structural failure. Digging beneath your foundation has the potential to destabilize your entire house and should be done in small sections, with extensive supplemental support. It may void your home insurance so discuss extensively with your engineer before pursuing underpinning.

CEILING HEIGHT . slab & elevation



Reference: Issues & Process

- **A** low profile floors (concrete, radiant heat & polish) pre-pour
- **B** removing old, thin slab for min. depth adjustment (and sewer-line work)
- **C** excavation of major height (power and manual work) with undisturbed soil at footer edges, for benched footers
- **C** benched footings poured (frame in place) with interior tile drains (pre-geotextile) in place
- **D** structure raised on cribbing , note holes in original foundation for I-beams prior to hydraulic lifting
- **D** structure raised on cribbing (after hydraulic lifting is done), awaiting new foundation piers or cellar walls (high risk)



HEIGHT INCREASE APPROACHES:

During structural assessment, your architect or engineer should measure–by sonar, cut, or core–existing elevations for footers, walls, and slabs, as well as current and potential ceiling heights. If you have low basement ceilings, your options to create a 7' tall basement will be determined by the 1) existing height, 2 & 3) the structure of your foundation and upper structure, and 4) the perimeter space around your building (offsets).

1. Existing Height: Basement excavation is costly, given the amount of manual labor and tight spaces involved. If you have a slightly short structure–8' to 8'6" from soil to joists -you can avoid digging costs and foundation damage risks by using thin assemblies (more rigid insulation, less loose, etc.). The easiest route is to simply conserve space.

2 & 3. Existing Structure–Foundation & Upper Stories: Typically, to get extra height, you'll want to excavate within your basement. Your wall and column footer may be much deeper than your thin slab and you can lower and repour the slab assembly with minor excavation. If you need multiple feet of depth, without disturbing your foundation or upper structure, you can excavate down and create bench footers. Both of these approaches are labor intensive but far less risky than raising a structure. Be mindful of the potential need for window wells and egress areas as you develop designs for a lower basement unit.

4. Elevation & Perimeter Offsets: If you can't dig down and have a simple frame structure and external workspace, it is possible to hydraulically lift your building and build walls up to meet a new elevation. This a common approach in sea-level rise mitigation, but, as with underpinning, is high risk because it moves the main structure.

MITIGATION COORDINATION:

A. THIN FINISHES (NO EXCAVATION)

Thinner finishes can remove the need for greater basement excavation but must maintain air/moisture/fire barriers.

Related construction required:

- coordinate slab work with radon, utilities, and drainage work
- insulate/enclose ceilings (around ducts) as fire partitions
- insulate & damp-proof slab/walls to work with drainage

B. EXCAVATE & REPLACE SLAB ONLY

Some houses have deeper footers,where thin slabs were belatedly added to mud floors. It is common to excavate this minor depth (plus drainage) and repour the slab. Make sure to isolate the slab from walls & footers.

Related construction required:

- coordinate elevations & slab work with beams/columns, radon, utilities, drainage work and new exits/basement doors
- insulate & damp-proof slab to be consistent with drainage

C. EXCAVATE & POUR BENCH FOOTERS

To gain significant height, without touching the foundation, you can excavate the floor (with a repose slope at edges) and pour bench footers. This can gain significant height and is less invasive than underpinning.

Related construction required:

- coordinate elevations & slab work with beams/columns, radon, utilities, drainage work and new exits/basement doors
- connect existing drains with interior drains & sump pump

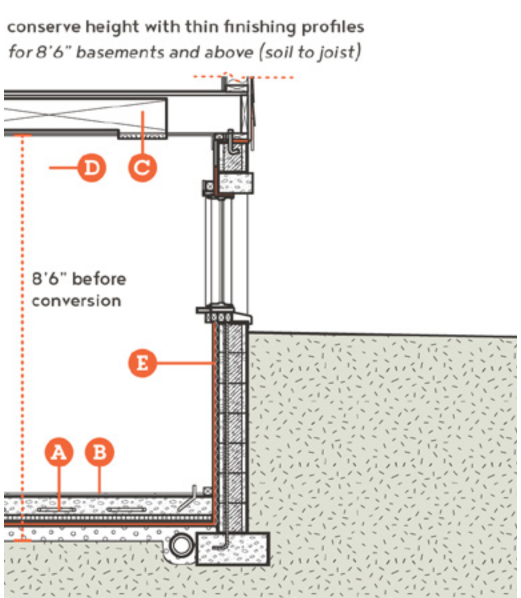
D. ELEVATE FRAME (+NEW SUPPORTS)

Akin to traditional house moving, it is possible to raise a simple building on I-beams and hydraulic jacks if you have space and cannot excavate.

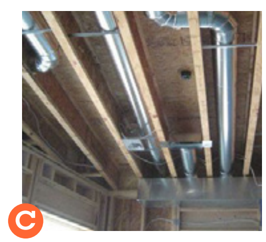
Related construction required:

- See slab comments above and note on cracks in underpinning.
- Requires extensive work space for I-beam maneuvering and additional jack supports/placement.
- The temporary crib supports will likely crack existing slabs so anticipate repairs, if not replacement. As with underpinning, you are likely to void your insurance.

A. THIN FINISHES (NO EXCAVATION)



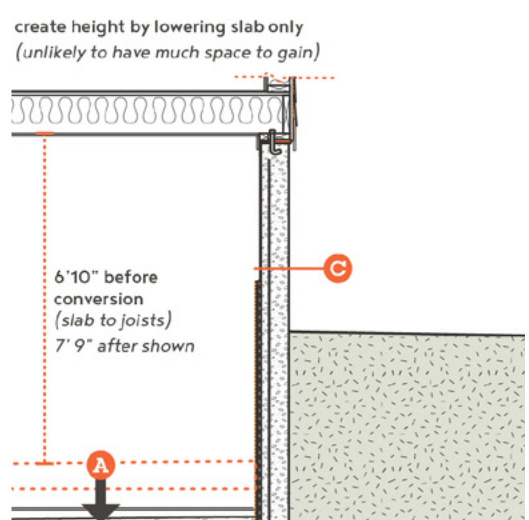
- **A** 4-5" slab with integrated radiant heat
- **B** tile for heat transfer (with underlaid membrane at joints, alt. would be polished concrete finish)
- **C** ventilation ducts within (mostly) joists for minimal height–make sure to insulate for efficiency, fire resistance
- **D** beams nested in walls to minimize height impact
- **E** drain tiles & exposed surface to avoid excess condensation



$2,000-$3,000 basic slab pour, not inclusive of heat

Thin slab replacement is done to conserve height while adding insulation, moisture/radon protection, adequate thickness to support unit loads, and, potentially, supplemental services like radiant heat. Cost will vary based on size, complexity of area/joints, and integration of heat. See ventilation and finishing for ceiling and wall approaches to space conservation.

B. EXCAVATE & REPLACE SLAB ONLY

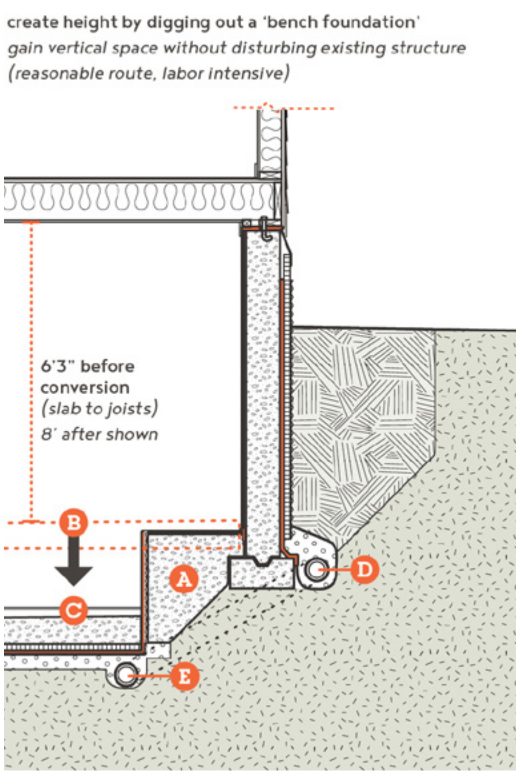


- **A** original slab height
- **B** new position, isolated (by vertical sand/gravel) over foundation footers, joints 10' x10' or 1:1.5 ratio at columns
- **C** typical exposed wall assembly with drainage tiles & moisture barriers to 1' above ground
- **D** typical 4" perforated PVC pipe with drainage boards, geotextiles, & gravel for interior tile drainage (p140)

$2,500-$4,000 demolition of existing structures + slab
$2,000-$3,000 basic slab pour

Minor slab excavation and replacement is done to create height while adding insulation, moisture/radon protection, and adequate thickness to support unit loads. As in approaches A and C, it should be coordinated with water, sewer, and MEP updates, which have sub-slab components. Cost will vary based on size, complexity of area, joints, and final finishing.

C. EXCAVATE & POUR BENCH FOOTERS

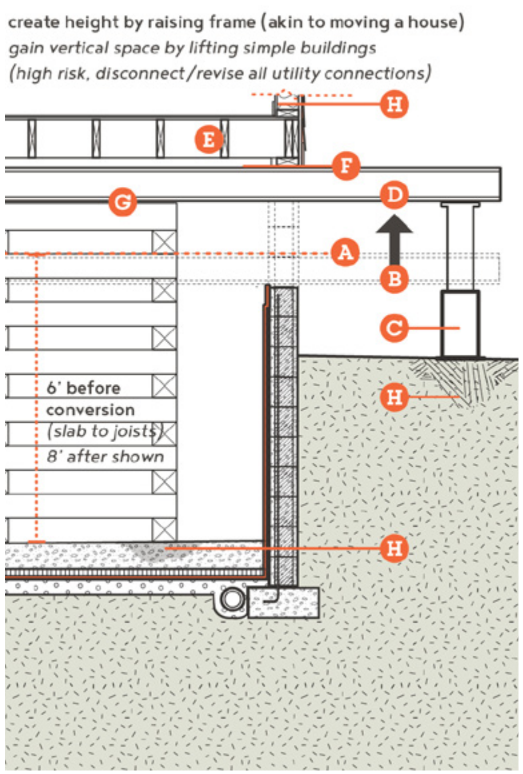


- **A** new bench footer, with undisturbed soil at angle of repose, reinforce as necessary
- **B** original slab height
- **C** new slab position (see B in 'Excavate & Replace')
- **D** original exterior tile drains to be connected with:
- **E** new interior drains and sump pump

$12,000-$21,000 **excavation & bench footer creation**

Major excavation and addition of bench footings is done to create significant ceiling height while laterally supporting existing footers (slabs conform to comments in minor excavation, approach B). Existing exterior foundation drains should be connected to new, interior perimeter drainage and sump pump systems. Cost will vary based on size, depth (digging method/labor), and complexity of area excavated as well as jointing and finishing desired.

D. ELEVATE FRAME (+NEW SUPPORTS)



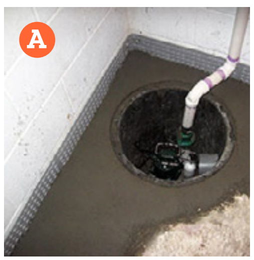
- **A** original wall height (hole at top)
- **B** I-beam inserted under joists (perpendicular)
- **C** hydraulic jacks for lifting (requires workspace)
- **D** final I-beam height
- **E** original joists, new location-shim as necessary for lift
- **F** final sill/wall height-build up
- **G** temporary supports (timber cribs)
- **H** likely areas of stress

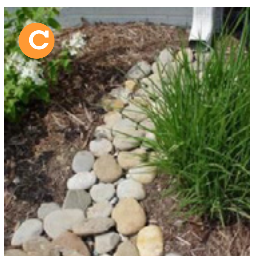
$3,000-$14,000 **hydraulic lifting & stabilization**

$10,000+ **edits and alterations to extend basement walls**

Raising a building is a high risk maneuver and requires significant additions to the foundation walls as well as likely repairs to upper walls and areas of temporary cribbing impacts. Cost will vary based on size and complexity of structure.

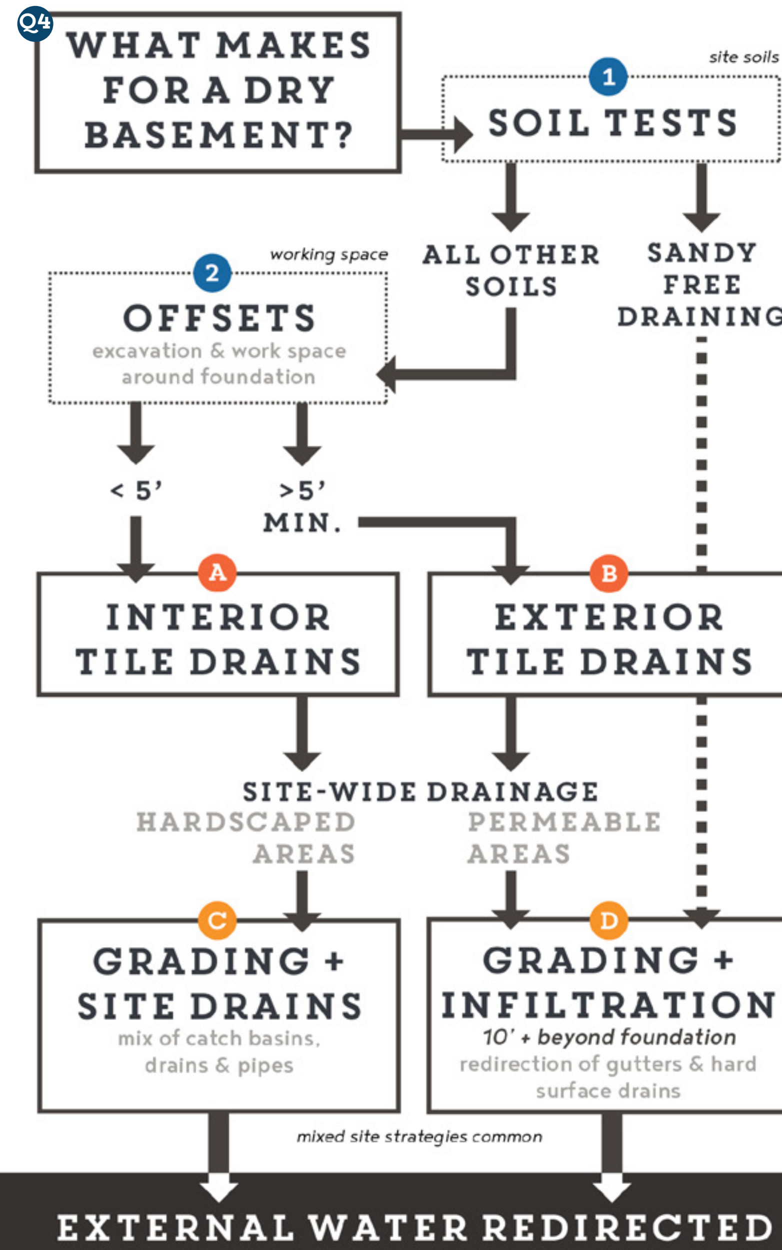
AREA DRAINAGE . water management





Reference: Installation Process/Pieces

- **A** Drains–4" PVC with weep holes–next to gravel trench (geotextile sleeve on section at bottom, in trench)
- **B** exterior drain pipe (pre-geotextile) adjacent to drainage-board/damp-proofing covered foundation wall
- **A** sump pump with new concrete patching over interior tile drains, drainage board visible above edges
- **C** exterior soft strategy - open channel (rocks to diminish water velocity) from downspout to permeable areas
- **D** exterior hard strategy (mixed)–downspout to PVC line with emitter to release water at lawn
- **D** exterior hard strategy–downspout to basin (to larger piped drainage/stormwater system)



SITE DRAINAGE APPROACHES:

Your approach to creating a dry basement will be determined by your building site, given 1) soil composition and natural drainage and 2) building offsets and perimeter work areas.

1. Soil Composition/Soil Test: Your architect or engineer should do soil cores/test pits to determine existing drainage potential. If you're lucky, your site has sandy soils which drain without assistance. That said, any mix of sand with loam or clay will trap groundwater and require a drainage system to move flows away from your foundation.

2. Offsets/Perimeter Space: Where you place drainage is determined by your working space. If there is room to work (ideally 10' offset) external excavation can be done to place tile drainage, vapor/damp-proofing, and insulation on the outside of your foundation walls, preserving interior space. If you lack external room (less than 5'), you can add tile drainage at the inside of footings. In this scheme, water flows through the foundation walls, down drainage boards to gravel and drains. Moisture and condensation are stopped by moisture/vapor barriers and rigid insulation on the inner foundation wall edge, before reaching any finishing materials. In both cases, water flows to perforated PVC drains which, as shown on the next page, connect to sump pumps to be raised to lawn or the combined storm & sewer system (cso) for disposal. In the rare case that your foundation is higher in elevation than the cso connection, tile drains may simply connect and drain by gravity (1-2% slopes).

In addition to the intensive installation of tile drains, you should keep water out of the area next to your foundation by using soft strategies–slopes to promote run-off and remote infiltration areas for downspouts- as well as hard conduit connections to the cso system, like catch-basins, trench and french drains, and maintenance clean-outs.

MITIGATION COORDINATION:

A. INTERIOR TILE DRAINS (FOUNDATION)

If you have water coming through your foundation, but no space to address on the outside, you will need to add interior drains and a sump pump to intercept those flows.

Related construction required:

- coordinate with slab patching (at edges) or replacement, radon venting, and utility connections (to the cso)
- combine with siteworks redirecting surface water (C, D below)

B. EXTERIOR TILE DRAINS (FOUNDATION)

If you have water coming through your foundation and space to work on the outside, you can add exterior drains.

Related construction required:

- perform in tandem with foundation repairs (as necessary)
- coordinate with slab patching (at sump), radon & damp-proofing membranes/venting, and utility connections (to the cso)
- combine with siteworks redirecting surface water (C, D below)
- requires excavation permit if within 10' of site boundary

C. SITE GRADING & SOFT SYSTEMS

In addition to foundation drains, your larger site should be graded to move water away from the foundation (2%+ slope). Collection areas, for permeable absorption, should be at least 10' from the building.

Related construction required:

- combine with foundation drains & 'hard' drainage below
- coordinate with any new doors, areaways, and window wells needed for egress, light, and ventilation

D. SITE GRADING & HARD SYSTEMS

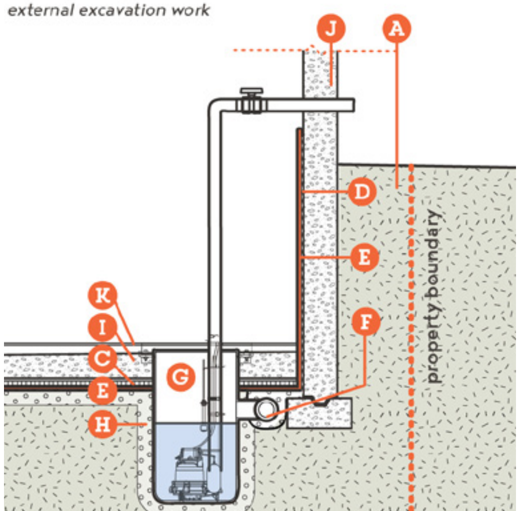
In addition to permeable areas, you should use catch-basins and extra french/trench/area drains and pipes to redistribute water and connect downspouts and cso systems.

Related construction required:

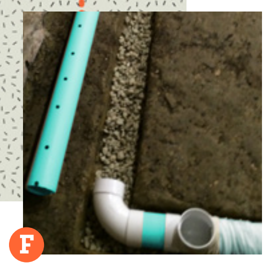
- same comments as 'C. site grading & soft systems' above

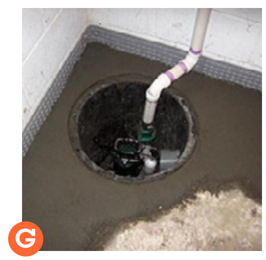
A. INTERIOR TILE DRAINS (FOUNDATION)

internal tile drainage with a sump pump
sites without space for external excavation work



- A site–no work space
- D drainage board–1' above grade
- E water barrier–1' above grade – vapor/water barriers continuous below slab
- F 4" PVC perimeter drains, geotextile wrap on placed pipe
- G sump pump
- H 4" gravel drainage
- I 4"+ concrete slab, with joints
- J foundation wall
- K finished floor
- L exposed walls



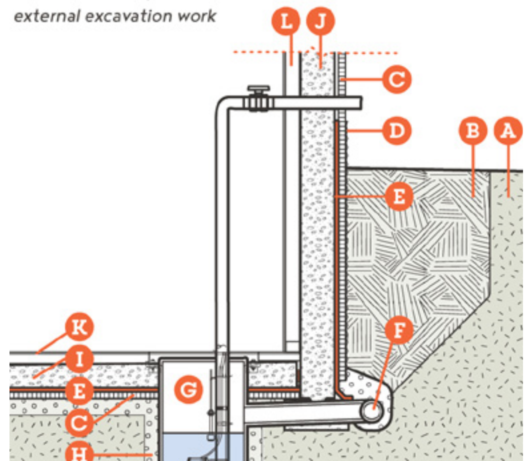


$3,500-$6,000 **drainage plane, insulation for slab**
$6,000-$10,000 **sump pump & tile installation**

Interior tile drainage allows water to pass through your foundation, with drainage board directing it down to sub-slab drains. Water/vapor barriers minimize leaks and insulation limits internal condensation in finished walls, Costs vary by size of area to be drained, combined slab work, and sump pump size/disposal connections.

B. EXTERIOR TILE DRAINS (FOUNDATION)

external tile drainage with a sump pump
sites that have space for external excavation work



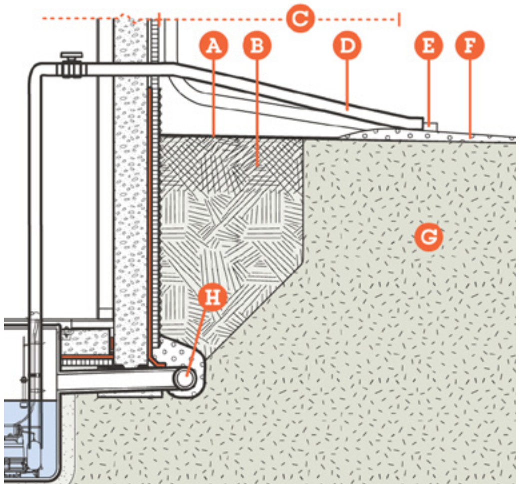
- A site–excavation space
- B backfilled area, gravel at drainage pipe
- C rigid insulation to top of wall–limits condensation in walls (L)
- D-E see labels for interior drainage
- F 4" PVC perimeter drains wrapped in filter fabric
- G G-L see labels for interior drainage, finish may vary

$6,000-$10,000 **sump pump & tile installation**
$3,000-$7,000 **air-dampproofing membranes**

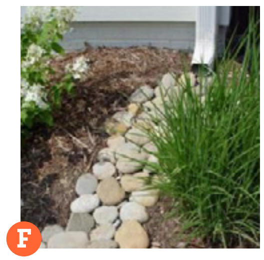
Exterior tile drainage, with external moisture barriers and insulation, drain water from soils adjacent to the foundation while minimizing internal condensation in the foundation and finished walls. Insulation minimizes thermal changes so areas above grade are protected from freeze/thaw. Costs vary by size of area to be excavated/drained, foundation wrapping, and sump pump size/disposal connections.

C. SITE GRADING & SOFT SYSTEMS

soft systems: sump pump, downspouts, permeable surfaces
sites with space (5'+) for absorption beyond foundation
(may be mixed with hard systems)



- **A** 2% slope minimum for water to flow away from building
- **B** engineered backfill
- **C** min 5-10' distance before water release & absorption
- **D** outlet for 2" sump pump pipe with backflow valve
- **E** downspout outlet
- **F** gravel or ceramic to slow water velocity/prevent erosion
- **G** permeable area
- **H** exterior tile drain assembly

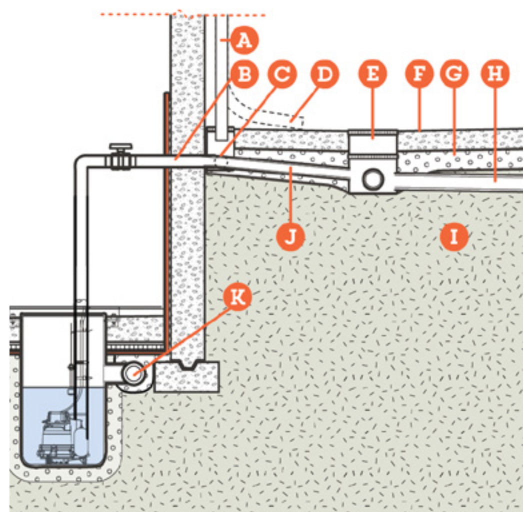


VARIES BY GRADING EXTENT

In addition to foundation drains, your site grading, sump pump and downspout discharges should be located to minimize water near the foundation. 2% downward slope should encourage rain to runoff to other areas. Open release of water should only occur in permeable areas 5-10' away from the foundation (for slow migration, evaporation, or plant absorption.) Costs vary by extent.

D. SITE GRADING & HARD SYSTEMS

hard systems: sump pump, downspouts, area drains
sites without space (5'+) for absorption or with paved areas
drainage to cso system (may be mixed with soft systems)

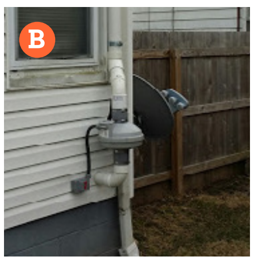


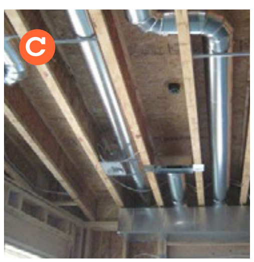
- **A** downspout
- **B** 2" sump pump pipe with discharge to surface drainage system and cso
- **C** direct connection (beyond) to drainage system and cso
- **D** alt. downspout to hard area
- **E** larger 9" area drain (6"-12" var.)
- **F** 1% slope, concrete (4" thick)
- **G** gravel bedding
- **H** 4" drain pipe to storm/cso system via gravity
- **I** undisturbed soils
- **J** internal system connections

$1,300-$2,300 per area drain
$1,600-$2,200 areaway additions

In combination with soft strategies, you should integrate 'hard' conduits (slope 1% min) to facilitate drainage from impermeable areas to the cso system or permeable zones. Elements like trench and area drains should be placed near basement entries to eliminate potential flooding. Costs vary by number of drains, connections, and clean-outs.

AIR SAFETY . radon . ventilation

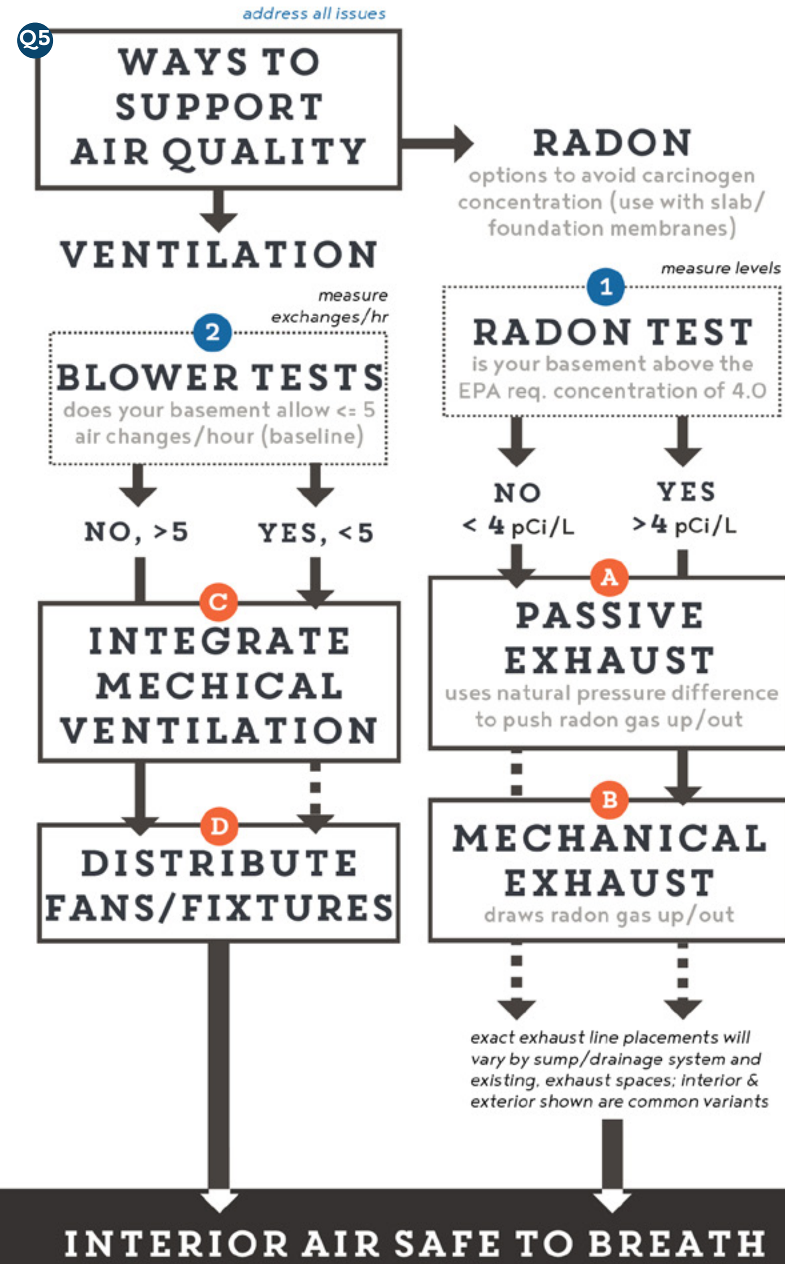




Reference: Test & Elements identified

- **1** radon detection–smaller domestic detector for basement installation
- **A** passive radon vent (PVC pipe), note detection monitor (red) and warning signage (radioactive sign)
- **B** mechanical radon vent, with vent fan and wiring visible on house exterior
- **2** blower test to determine air-tightness and, in combo with natural vent., determines ventilation system needs
- **C** typical low profile system of ventilation/heat duct work
- **D** fan installation, required in bathrooms, for focused air/moisture abattement

Radon is a naturally occurring radioactive gas produced by the breakdown of thorium and uranium in soil, rock, and water. It is the only gas that has radioactive isotopes, under standard conditions. and is considered a health hazard due to its radioactivity level.



AIR SAFETY APPROACHES:

Your approach to interior air quality will be determined by 1) the natural rate of radon release in your area (geology and soils) and 2) the relative internal moisture condensation and air circulation of your basement.

1. Radon Seepage: Radon comes from the breakdown of uranium in soil, rock and water and gets into the air you breathe (see EPA: www.epa.gov/radon). It is the second highest cause of lung cancer, after smoking. There is no safe level of radon exposure. As basements are the lowest area of a house, with relative low air pressure (vs. soil and outdoors), they can act as a vacuum. Unsealed floor and wall cracks, uncovered sumps, and loose fitting drains allow radon to seep in and concentrate in the air. For this reason all renovations are required to add vapor-barriers and sub-slab exhaust for all basements. You should purchase a radon test, available at hardware stores, to determine the current radon level in your basement. If higher than 4 pCi/L, you must install a mechanical system (also encouraged for 2-4 pCi/L).

2. Air Circulation and Moisture: Basements tend to be naturally insulated and often have less ambient air change, leading to extra moisture, wall condensation, and mold growth. For existing buildings, a blower test is done to determine air tightness. A high powered fan pulls air out of the house, lowering the air pressure inside and an airflow manometer measures the rate of infiltration through the structure. Conservatively, if your design has minimal natural ventilation and new vapor barriers (for radon),you should integrate mechanical ventilation–with intake and exhaust fans–to achieve a minimum of .35 air changes per hour and stable air pressure. If you achieve 5+ air changes, you can combat moisture and mold by installing mechanical vents in baths (req.), kitchens, and still areas like closets. Dehumidifiers can help reduce residual moisture. Existing mold should be treated with antifungals in tandem with increased ventilation and dehumidification.

MITIGATION COORDINATION:

A. RADON—MECHANICAL EXHAUST

For high radon levels (4 pCi/L), mechanical radon exhaust systems use a fan to pull radon out of the sub-slab area (accelerating the process in B. below). Passive systems can be converted to active by adding fans.

Related construction required:

- coordinate placement with slab repair/replacement and
- vapor/moisture barriers for drainage systems
- all sump pumps should be air-tight to avoid radon leaks

B. RADON—PASSIVE EXHAUST

For low radon levels (<4 pCi/L), the passive exhaust system relies on higher air pressure at the foundation to push radon toward low pressure areas in the environment above, where it can dissipate at the top of the exhaust pipe.

Related construction required:

- see comments under 'A. Radon–Mechanical Exhaust'

C. VENTILATION—CENTRAL SYSTEM

If lacking adequate natural ventilation (or having excessive air-tightness), basements are required to have mechanical ventilation. While it is common to find exhaust only and intake only (single direction fans) in older duct systems, those pressure imbalances can exacerbate radon issues. A system with dual fans (in and out) is recommended for balanced air circulation.

Related construction required:

- coordinate with MEP/heating additions and natural ventilation
- coordinate depth/duct design with joist and beam layouts

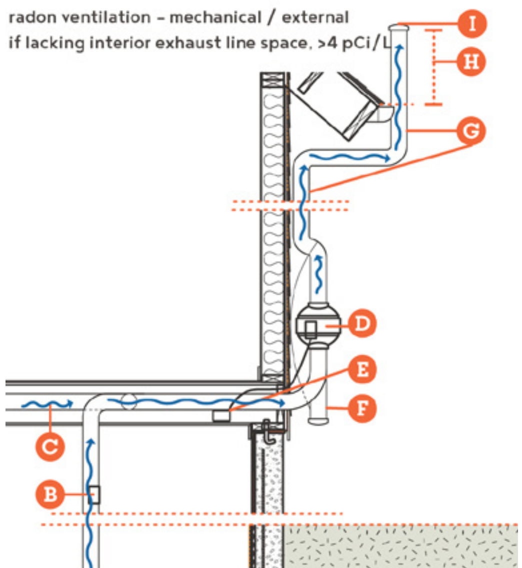
D. VENTILATION—DISTRIBUTED

Even without central systems, wet rooms like bathrooms must have focused fans, to vent humidity and moisture to the exterior.

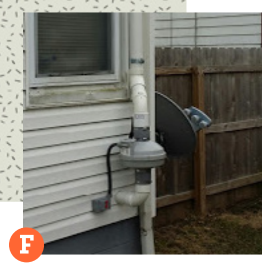
Related construction required:

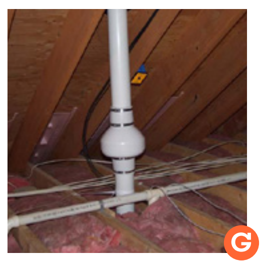
- coordinate placement with plumbing (water/sewer shafts), fixtures, and joists
- coordinate with centralized ventilation as needed (exhaust)

A. RADON -MECHANICAL



- **A** 4" PVC pipe open to drainage area beneath vapor barrier & slab
- **B** radon level monitor
- **C** additional vent pipes (from sump pump or ext. drains)
- **D** fan wired inside
- **E** interior circuit & monitor connection
- **F** water bypass/ condensation area for clean-out
- **G** brace on building
- **H** 1' taller (min.) than roof
- **I** rain cap on top opening

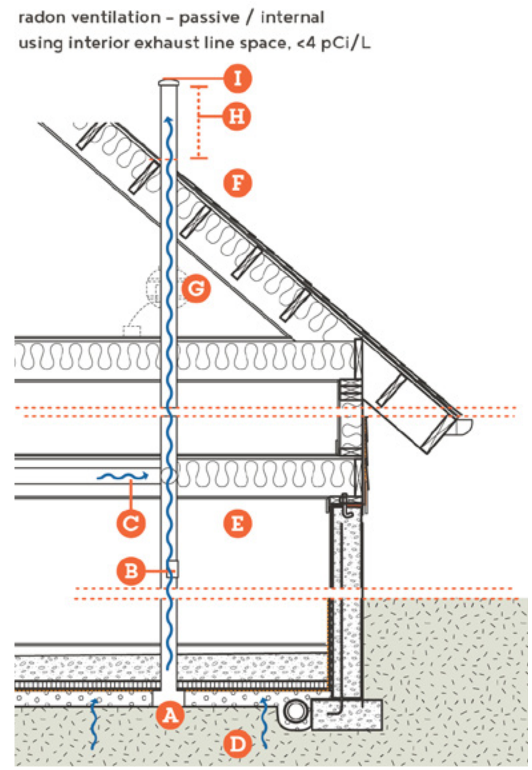




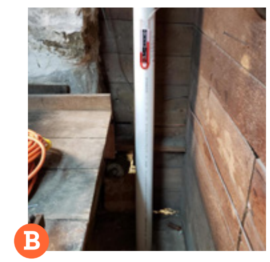
$3,000-$7,000 **slab & wall sealing/dampproofing**
$500-$2,500 **piping, fan, and exhaust**

Mechanical exhaust supplements the natural vacuum of passive exhaust with a constant fan–typ. on house exterior or in rafter spaces–that is linked to constant power and basement-level monitors. Costs vary by extent of vapor-barrier (slab and wall work) and complexity of pipe system.

B. RADON -PASSIVE EXHAUST



- **A–C** see mechanical system for A-C
- **D** high pressure source of radon seepage (direct leaks stopped at vapor barrier)
- **E** low pressure area of concentration (ceiling)
- **F** mid-low pressure outside (for natural vaccum)
- **G** optional fan addition
- **H** 1' taller (+) than roof
- **I** rain cap on top opening

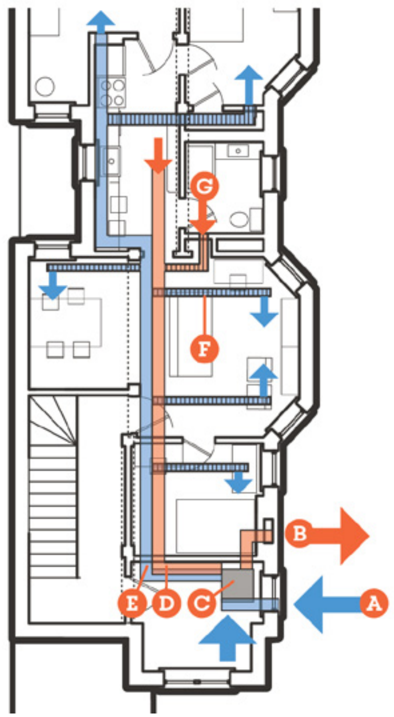


$3,000-$7,000 **slab & wall sealing/dampproofing**
$500-$2,500 **piping and exhaust**

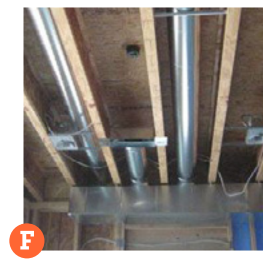
A passive exhaust system is fairly simple: a sealed 4" PVC pipe runs from beneath your vapor-barriers and slab (plus sump area) to exhaust at min. 1' foot above your roof and highest level of occupation. Installation should be done with slab and drainage work. Cost vary by extent of vapor-barrier (slab and wall work) and complexity of the pipe system. Fans themselves (for mechanical conversion) only cost around $500.

C. VENTILATION—CENTRAL SYSTEM

unit-wide ventilation given low air exchanges



- **A** fresh air intakes (exterior & interior)
- **B** stale air exhaust, chimney
- **C** heat exchange, AC, or heater to temper air with 2 fans (in, out)
- **D** exhaust return line
- **E** fresh air distribution line (system to be sized by heating specialist)
- **F** smaller laterals to vents in bedrooms, living areas
- **G** return vents in kitchen, bath

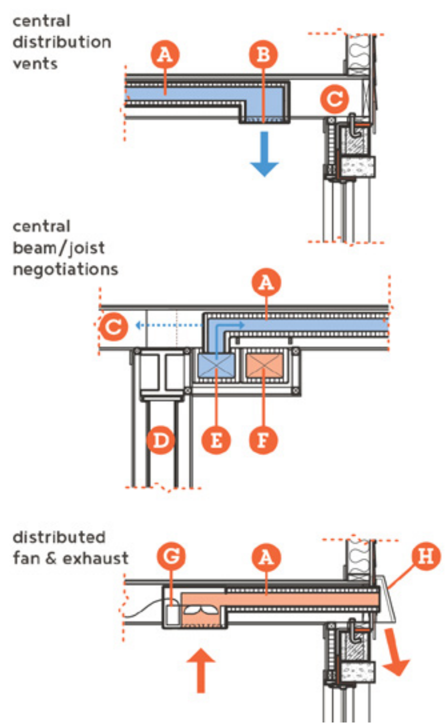


$1,200-$4,600 full unit ductwork (with single unit furnace)

You are likely familiar with ventilation in combination with air conditioning (AC) and forced air heating. With or without these options, a balanced ventilation system should provide fresh air, with: intake fan(s), insulated ducts, and distribution vents in bedrooms and main living areas. On the exhaust end, it will include return vents in bathrooms and kitchens, which link to exhaust fans and exterior release. In-line dehumidifiers, heat exchangers, and AC can all be integrated to adjust unit temperature and humidity levels. Costs vary by system complexity.

D. VENTILATION—DISTRIBUTED FIXTURES

central vs. distributed fans (humidity control)

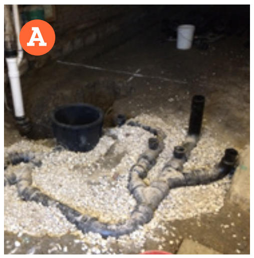


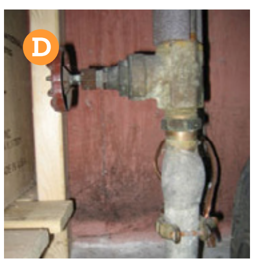
- **A** insulated duct (6")
- **B** fresh air vent
- **C** placed between joists
- **D** system adjacent to beams, add lateral lines over beams as needed
- **E** main fresh air duct (galvanized steel + insulation, 2x2 framed & finished)
- **F** main return/exhaust duct
- **G** bath fan wired with lights
- **H** exhaust vented at header, with vent cover

$300-$700 per fan (bath or kitchen)

If you have adequate natural ventilation, by code, and > 5 air changes, you must still install individual bathroom fans for localized humidity control. Similar fans can be added–insulated and ducted to the exterior– as well as dehumidifiers in other problem areas like kitchens and closets with low air flow and/or high moisture content. Individual fans are inexpensive but require power and venting areas. Be wary of creating unbalanced pressure.

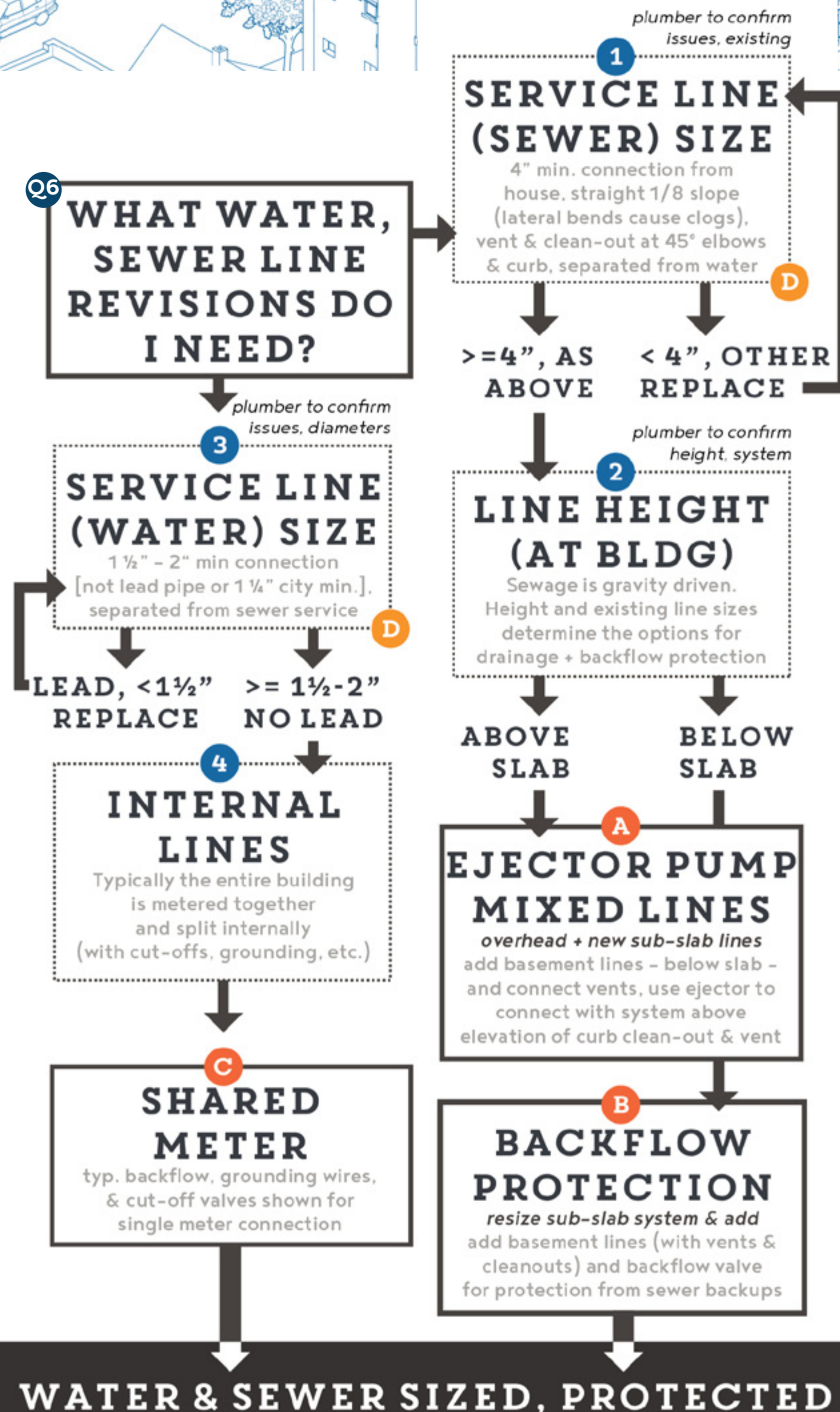
SEWAGE & WATER. sizing . backflow





Reference: Element, Issues identified

- **A** under-slab bathroom lines in place, connecting to ejector pump basin
- **A** ejector pump with vent (r), cut-off valve and overhead connection to lateral lines (laundry -> service lines)
- **B** sub-slab sewer lines with backflow protection valve, connecting to upper lines & low sewer service line
- **C** water connection at meter, with grounding wires visible
- **D** common sewer vent & clean-out seen at property edge / connection joint with city service
- **D** old lead water service line (note bulge) for water, at cut-off valve in advance of meter



PLUMBING UPDATE APPROACHES:

Your approach to sewer and water updates will be determined by 1) the size (volume) and condition of your service connections running from your building to city mains at the curb, 2) the elevation of your sewer service, as a system of gravity-based flows, and 3) your preference for separate or combined metering of units' water.

1. Sewer connections (volume, slope, angle): Your plumber will advise on the needed size and slope of your sewer's service connections based on anticipated fixtures and service line length. At minimum, you must have lines of 4" dia. (for multiple units), 1% slope, ideally lacking lateral bends, and with a clean-out and vent at the curb.

2. Sewer height (relative to slab and curb vent/clean-out): Your plumber should also advise on adding an ejector pump and/or backflow protection based on the elevation of your sewer connection. Any fixtures, drains, or connections that are beneath the elevation of your curb clean-out will require backflow protection (see drawings A and B for integration, next page).

3. Water connections (volume, flow/pressure, pipe materials): Your plumber will advise on the needed size for water service connections based on anticipated fixtures, overall elevation (highest fixture to raise water to), pipe materials' friction, and overall plumbing system length. Sizes at left are from approx. calculations in 'Code Compliant Units', pg 77. Older buildings are also likely to have lead lines, which must be replaced.

4. Water meters (standard metering and line details): Meters can be added before or after lines are split for individual units and will depend on whether you want to separate and track tenant usage (with separate water heaters, in-unit washers, etc.).

MITIGATION COORDINATION:

A. SEWER -HIGH—EJECTOR PUMP

For all sewer updates, you may need to add larger pipes, as discussed in 'Code Compliant Units,' straighten service lines (D below) and add clean-outs to eliminate backups. If your sewer lines connect above the slab, you can add sub-slab drainage with an ejector pump. See drawings to coordinate elevation, venting, and backflow protection.

Related construction required:

- coordinate pump placement, new lines, and drainage slopes with existing vents, elevations, slab, and drainage work
- make sure water and sewer connections are separated (5' min.)

B. SEWER—LOW—LINES + VALVES

See note in A on service connections. If your sewer lines connect below slab, you can revise pipe sizing for new fixtures and add backflow protection valves to prevent basement flooding (selectively patch slab).

Related construction required:

- see comments on A above and D below

C. WATER CONNECTIONS

Most likely you will need to replace/enlarge old lead service connections for adequate water flow/pressure (install system filters to be safe). It is your choice how to split units' water (separate or single meter) as long as you have required cut-off values and backflow protection.

Related construction required:

- coordinate connections to avoid sewer lines and foundation drainage infrastructure
- make sure to incorporate MEP decisions in overall line layouts

D. PROPERTY/CURB CONNECTIONS

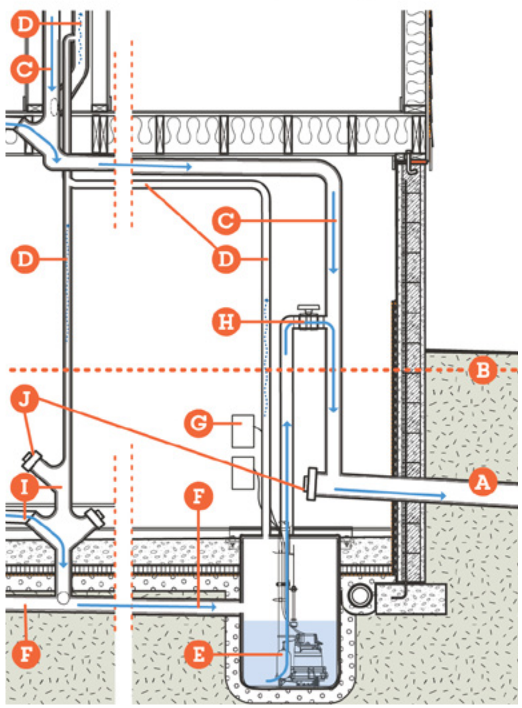
This reference highlights the cut-offs and vents required on service lines at the property edge, connecting to water and sewer mains. Lins should be kept straight (no lateral bends), separated (to avoid contamination), and vented (for sewer gas).

Related construction required:

- in areas with combined sewage & storm water systems (cso), hard site drainage should send water to the sewer main.

A. SEWER—HIGH—EJECTOR PUMP

sewer ejector pump, exhaust, & overhead connections
for connections above slab level (more likely)



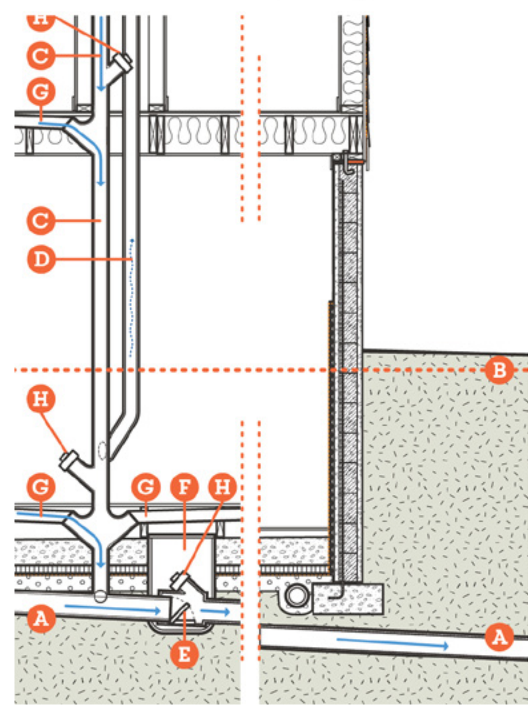
- **A** 4" min. service line (3' below grade)
- **B** height of vent at property (backflow valves protect elements below this line)
- **C** drainage stack - overhead to service connection
- **D** sewer gas vents (to vent stack and exterior exhaust)
- **E** ejector pump
- **F** sub-slab lines to pump
- **G** power & backup (2 circuits)
- **H** pump connection & backflow valves
- **I** lateral lines to sink, toilets
- **J** clean-outs

$2,000-$7,000 pump, $4,000-$5,000 lines

An ejector pump collects and grinds sewage from low lines (F). It pumps this mixture up–above the main's clean-out/overflow elevation (B)–to joint the main drainage stack. This, along with backflow valves (H), protects your basement from sewer flooding. Clean-outs on the drainage stack, as well as exhaust and vent stacks should be incorporated as shown. Costs vary by size of pumped area, slab work for new lines and vents, and ejector pump connections.

B. SEWER—LOW—BACKFLOW VALVES

sewer sizing, backflow protection, & exhaust
for connections below slab level (less likely)

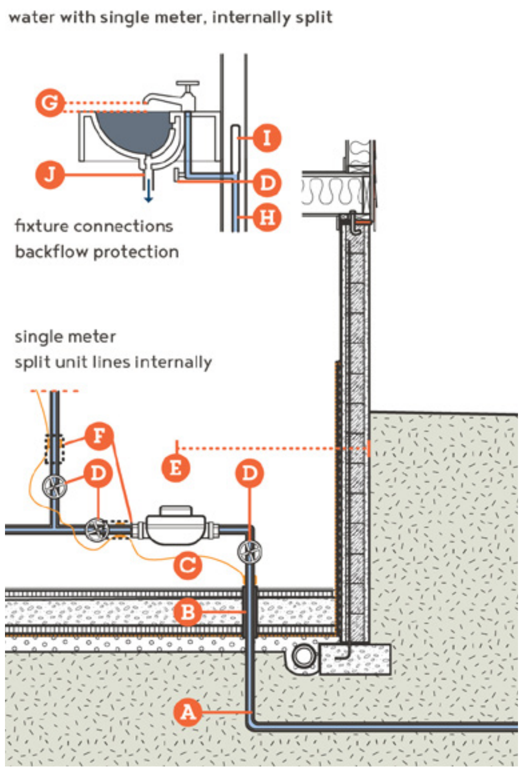


- **A** 4" min. service line below slab
- **B** height of vent at property (backflow protection needed below this line)
- **C** existing drainage stack
- **D** vent stack (connections above fixture traps)
- **E** backwater valve
- **F** access hatch (sealed against radon leaks)
- **G** horizontal drainage lines (to sinks, toilets, etc.)
- **H** clean-outs

$4,000-$5,000 lines & exhaust, $800 cleaning

For the rare case of low, sub-slab sewer lines, you can add a backwater valve on your main sewer connection, in advance of basement drains or main drainage stacks. This will protect your basement from sewer flooding due to clogged pipes. Clean-outs and vent stacks should be incorporated as shown. Costs vary by amount of slab work needed to add pipe capacity/size and install the new lines themselves.

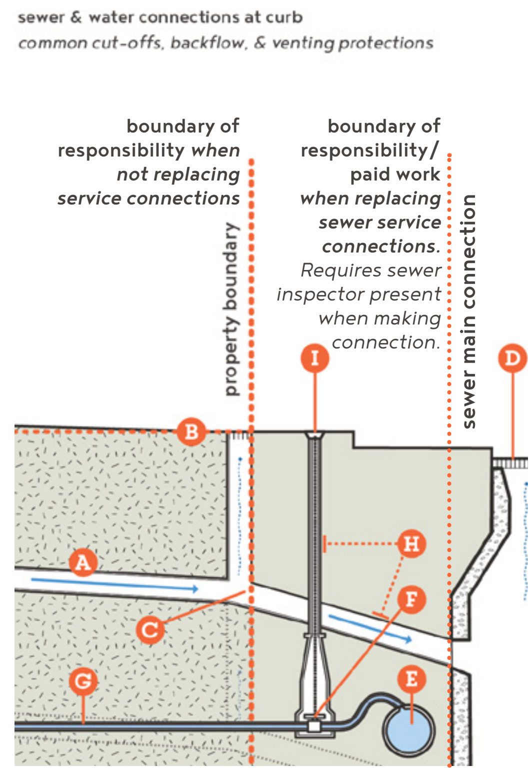
C. WATER CONNECTIONS



- **A** water service line
- **B** water-tight sleeve
- **C** 'jump line' grounding wire (by passes meter)
- **D** 'full-open' shutoff valves:
  - before & after meters
  - vertical risers (>2 story bldg)
  - on supply for all fixtures, water heaters, unit pipes
- **E** meter, max 2' from wall
- **F** backflow protection valves on irrigation, sprinkler, hose lines
- **G** backflow protection: air gap at faucet/sink lip
- **H** in-wall supply (alt. above)
- **I** air chamber (pressure buffer)
- **J** to drain, trap, and sewer lines

$1,700-$5000 **water lines**
$1,000-$4,000 **per meter**
At minimum, you should install a new service connection sized for adequate water flow and pressure, given the addition of bath and kitchen fixtures. Older houses are often not metered in Chicago, so you can anticipate adding at least one meter on your grounded service line, with cut-off valves and backflow protection both before and after the meter. Costs vary by size of system and number of meters.

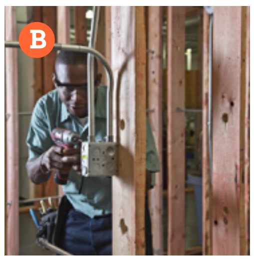
D. PROPERTY CONNECTION REFERENCE



- **A** higher sewer line elevation, owner responsibility boundary varies (lower line elevation, dashed black)
- **B** vent/clean-out serves as overflow
- **C** service connection, note on sewer boundaries
- **D** sewer main (at manhole)
- **E** water main (pressurized)
- **F** curb valve (water shut-off) in sidewalk, 18-24" to curb
- **G** water service line connecting to meters (typ. min. 1 ½" for domestic)
- **H** **water and sewer should have 10' lateral separation (different trenches)**
- **I** surface cap and rod to turn shut-off valve

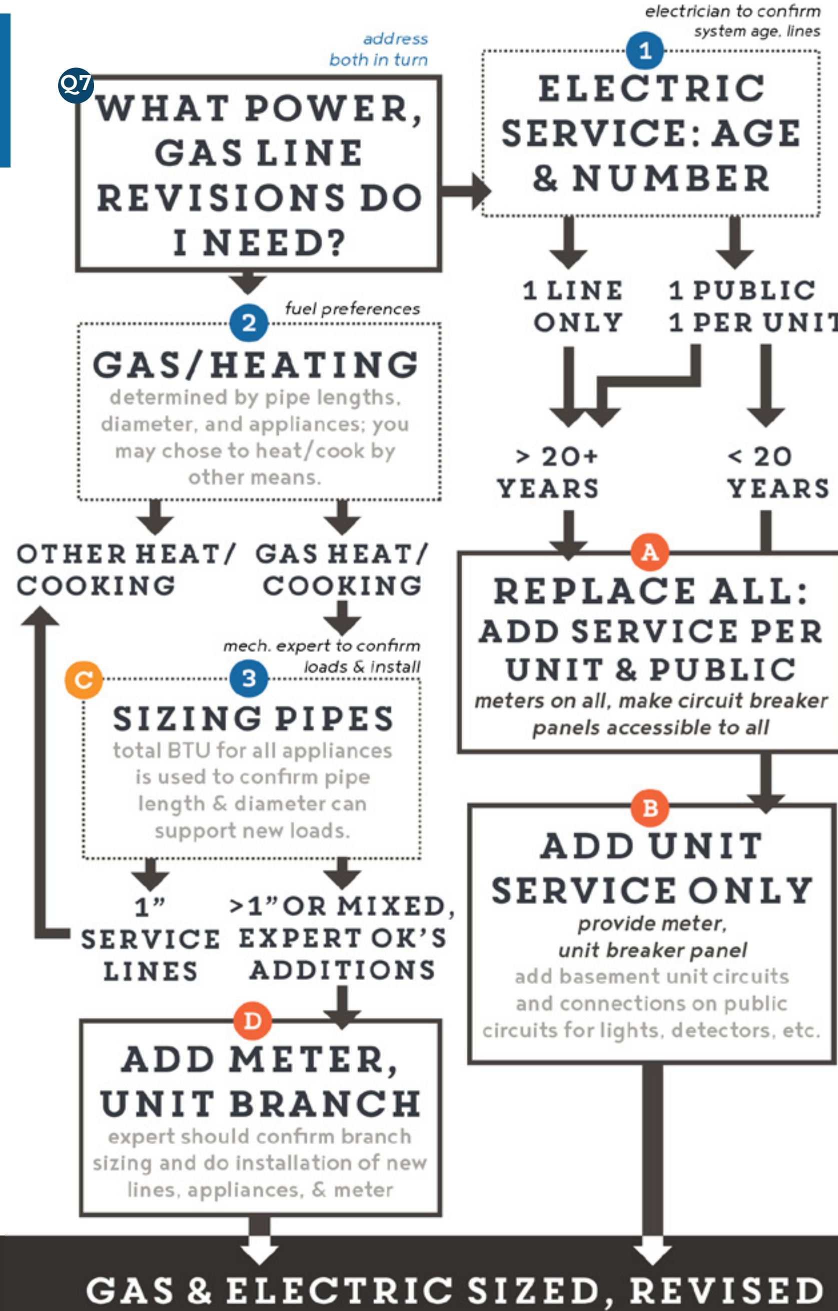
$15,000-$21,000 **per new service connection**
New service connections are expensive but commonly required for single family homes, given their smaller starting water and sewer capacity. See rough sizing calcs on p77. Most likely, you will need to install a new water service connection, sized for both water flow and pressure with additional fixtures. In addition water and sewer should be in separated trenches, each with straight, appropriately-sloped lines with appropriate cut-offs, vents/clean-outs and traps at fixtures to avoid sewage clogs and gas backflow.

ELECTRIC & GAS . options . updates



Reference: Issues & Elements identified

- **A** dangerously old wiring, frayed/decayed insulation on circuits
- **A** outlets (L to R):
  - GFCI outlet: 15amp, + breaker reset buttons,
  - basic grounded outlets: 15amp, third hole
  - old ungrounded: two holes - *no longer legal, replace*
- **B** breaker panel, enclosed, per new electric service (see annotations next page)
- **B** roughed-in electric conduits –in advance of fixtures, and wall cover
- **D** common single meter, note pressure regulator at left, private shut-off valves on split lines at right
- **D** testing for gas leaks at connection near shut-off valves



ELECTRIC & GAS APPROACHES:

Your approach to electric and gas updates will be determined by 1) the age of wiring and the number of current electric services, and 2-3) the size and loading on your gas line. Because cooking and heating can be done with electricity, there's no immediate code reason to update a smaller external gas line, which is adequate for single family use, but not split, multi-unit service.

1. Number & Age of Electric Service connections:

- **Number:** Your building should have separate, metered electric service per each unit and common or public metered service for hallways, utility rooms, exterior lights, and the circuits powering smoke detectors and pumps. This allows each service to be shutoff (at the breaker box) for work and repairs. It's typical to have 100 to 200-amp and 120/240 volt circuits per service connection. Units with electric heat and electric appliances (instead of gas) may require up to 300-amp. Your electrician will calculate loads.
- **Age:** Because electric insulation decays over time and energy demands are higher than in the past, you should replace electric circuits every 20 years to avoid overloading wires (with electronics, air conditioning). In general, it costs less to add new wiring (per unit) than to trace, test, and replace specific deficiencies.

2. Fuel Preferences: Given environmental preferences, you may not be considering gas additions. In terms of costs, it can make sense to add electric appliances if you wish to avoid adding a meter or updating the gas company's external line.

3. Capacity/Size of Service Lines: Adding a meter and a new branch line for gas appliances can be inexpensive, as a unit may only need a single range connection (often 1/2" line). The following page unpacks the estimate from 'Code Compliant Units,' so you can calculate your needs. A heating and ventilation professional should estimate your building's gas usage, confirm service line size and capacity. In general, single family homes are more likely to have small service pipes, which may be inadequate for multiple units and new appliances.

MITIGATION COORDINATION:

A. ELECTRIC: ALL NEW SERVICES

Graphic explains circuits structure and current flow, from source to ground (akin to water + sewer). Photos show rough & finished electric installations.

For electric, tenants must have access to their breaker panels and public area panels. For whole house replacements, you will need to patch ceilings and walls within your existing unit(s).

Related construction required:

- coordinate additional public circuits to a) enable safe backup power to sump pumps, ejector pumps, and radon fans; b) enable the hardwiring of required smoke detectors in units and common areas; and c) provide adequate exterior lighting
- your electrician should determine required amperage per metered service, particularly if using electric heating, air conditioning, and cooking appliances

B. ELECTRIC: SINGLE NEW SERVICE

Graphic unpacks breaker panel, so you can follow organization of installed circuits per each unit.

Related construction required:

- see public circuit note in 'A. Electric: All New Lines'
- same unit amperage calculation applies as above

C. GAS: ESTIMATING LINE SIZES

A rough estimate of current and potential gas pipe sizing is possible, as shown in 'Code Compliance Units', pg 81. This schematic guidance should be supplemented by professional calculations.

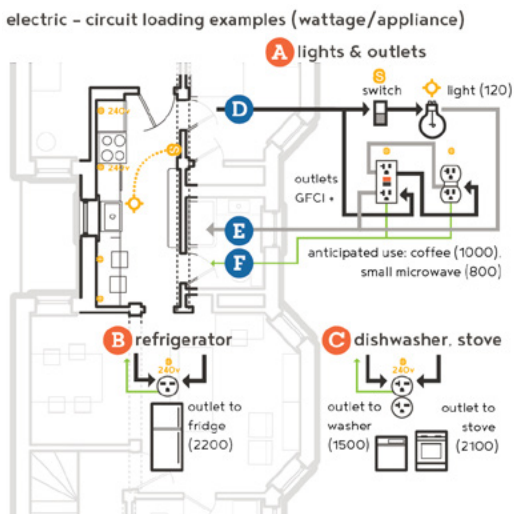
D. GAS: BRANCH LINE & METER

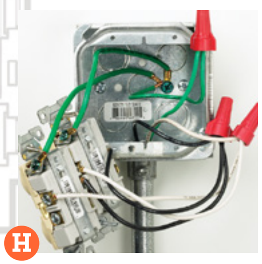
Gas lines are relatively easy to alter and adapt, akin to water piping. Updates (and system shut-offs) by your heating and ventilation specialist should be timed to minimize redundancy and maximize safety.

Related construction required:

- Gas lines are small, so they are unlikely to impact height or finishing profiles. See tables under C. for length/flow relation
- Coordinate updates with surrounding construction.

A. ELECTRIC: ALL NEW METERED SERVICES CIRCUIT DIAGRAM (KITCHEN)



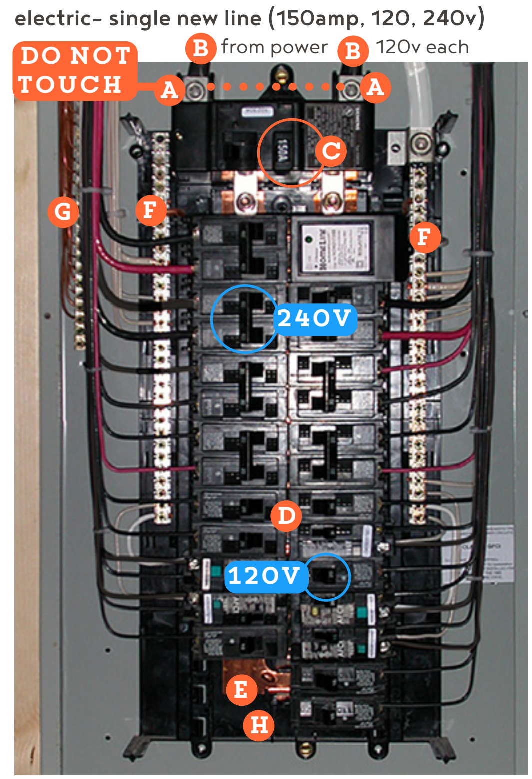


- **A** circuit 1 (120volt): overhead lights and 2 outlets in CFGI series (label on CFGI outlet) = 1920 watts/120volts*(1.25) = 20 amps
- **B** circuit 2 (240volt): fridge = 2200watts, calculated as above => 15 amps
- **C** circuit 3 (240volt): dishwasher, stove = 3600watts => 20 amps
- **D** hot power in (black)
- **E** neutral line to ground
- **F** grounding line (safety)
- **G** Rough Electric: wires in conduit between outlets but not connected.
- **H** Final Electric: wires have been joined in circuits, safely enclosed in screw terminals/at fixtures.

$20,000-$35,000 **lines for existing unit, public, basement**

For each new unit's electric service, your electrician will calculate the anticipated electric loads, akin to the calculation of kitchen appliance loading above. (Find wattage here: bit.ly/Wattage-Worksheet) Large appliances are typically located on separate circuits, with 240 volts supply; outlets and lights on 120 volt circuits. The sum of unit circuits dictates the total unit amperage, per metered electric service.

B. ELECTRIC: EACH METERED SERVICE—BREAKER PANEL

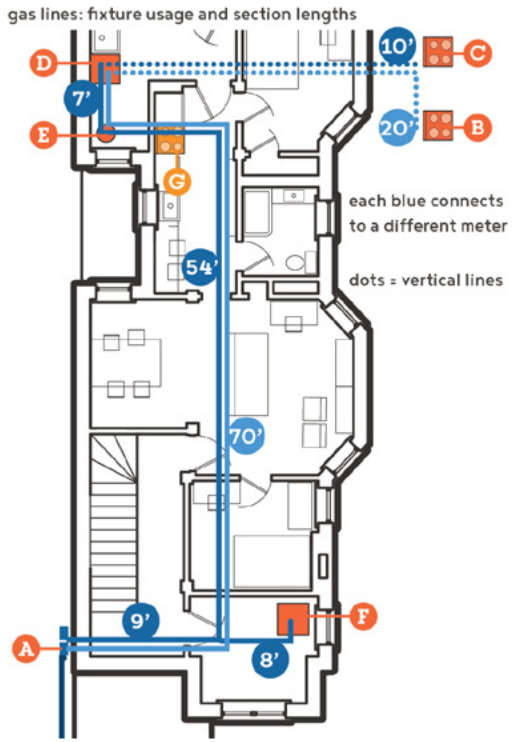


- **A** Main lugs: always live. **NEVER TOUCH THEM.**
- **B** Main cables (black): always live. Avoid touching them.
- **C** Main breaker: Main dis-connect; switch off before removing panel cover! (amps noted on switch)
- **D** Breakers. The hot wire (red or black) from each circuit connects to a breaker. Each breaker allows a specific amperage to flow and will 'break' the line given excess loading.
- **E** Breaker bus. (behind) Distributes power from the main breaker to the circuit breakers.
- **F** Neutral bus. All neutral (white) wires connect here.
- **G** These and the grounding lines (copper) connect to the main ground line, enabling electric flow.
- **H** Breaker spaces: room for breakers, amps permitting.

$5,000-$8,000 **new electric for unit only**

Each unit breaker panel should be fully enclosed, with circuits labeled and amps noted on breaker switches. *The exposed view is for explanatory purposes only.* Contemporary electric service, per unit, is at least 100-200-amps, with 120/240 volt lines. The power is metered (and can be locked for shut off) and then enters at the breaker box, with a main breaker for disconnection. Total amperage is subdivided into seperate circuits, each calculated to meet specific area's/appliances' loading.

C. GAS—ESTIMATING LINE SIZES



steel pipe

NOMINAL:	½	¾	1	1¼	1½	2	2½
ACTUAL ID:	0.622	0.824	1.049	1.380	1.610	2.067	2.469
LENGTH (feet)	capacity needed in ft³/hr						
10	172	360	678	1390	2090	4020	6400
20	118	247	466	957	1430	2760	4400
30	95	199	374	768	1150	2220	3530
40	81	170	320	657	985	1900	3020
50	72	151	284	583	873	1680	2680
60	65	137	257	528	791	1520	2430
70	60	126	237	486	728	1400	2230
80	56	117	220	452	677	1300	2080
90	52	110	207	424	635	1220	1950
100	50	104	195	400	600	1160	1840

Calculate segment pipe sizes from the end of line, moving toward the meter. Match capacity, on chart, based on the row for the furthest fixture, and add 5' for flexible connections. Any segment of pipe needs capacity for the remaining fixtures on the same branch.

- **A** **meters, one per line,** with pressure regulation (details to the right)

line to second floor unit

- **B** **furthest fixture** = stove (59 ft³/hr) @ 95ft pipe (20'+70'+5') = ¾" pipe

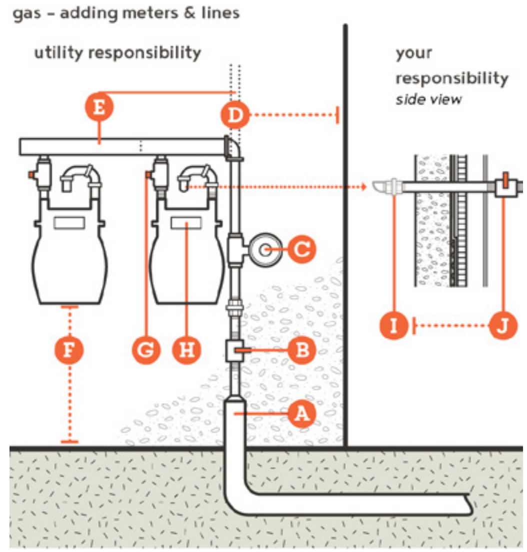
main line, to first floor

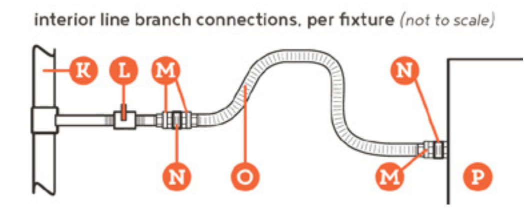
- **C** **furthest fixture** = stove (59 ft³/hr) @ 85ft pipe = ¾" pipe segment
- **D** drier (32 ft³/hr) + 59 = 91 ft³/hr = ¾" pipe segment
- **E** water heater (45 ft³/hr) + 91 = 136 ft³/hr = 1" segment
- **F** updated furnace (165 ft³/hr) = 1" pipe segment
- **final segment** = all fixtures (301 ft³/hr) = 1¼" pipe

entire building

- **G** all fixtures (360 ft³/hr) @ 95ft pipe = 1¼" service
- add electric range; *no load*

D. GAS—METERS & LINE CONNECTIONS





$7,00-$1,800 new line, meter added

Expanding on the 'Code Compliant Unit' samples and instructions, the diagram at left calculates segment size requirements. A meter should be added for all new lines, with pressure regulation, safety valves, and spacing as shown above. All fixture lines must have cut-offs and tightened connections to avoid leaks. Costs vary by branches/fixtures added.

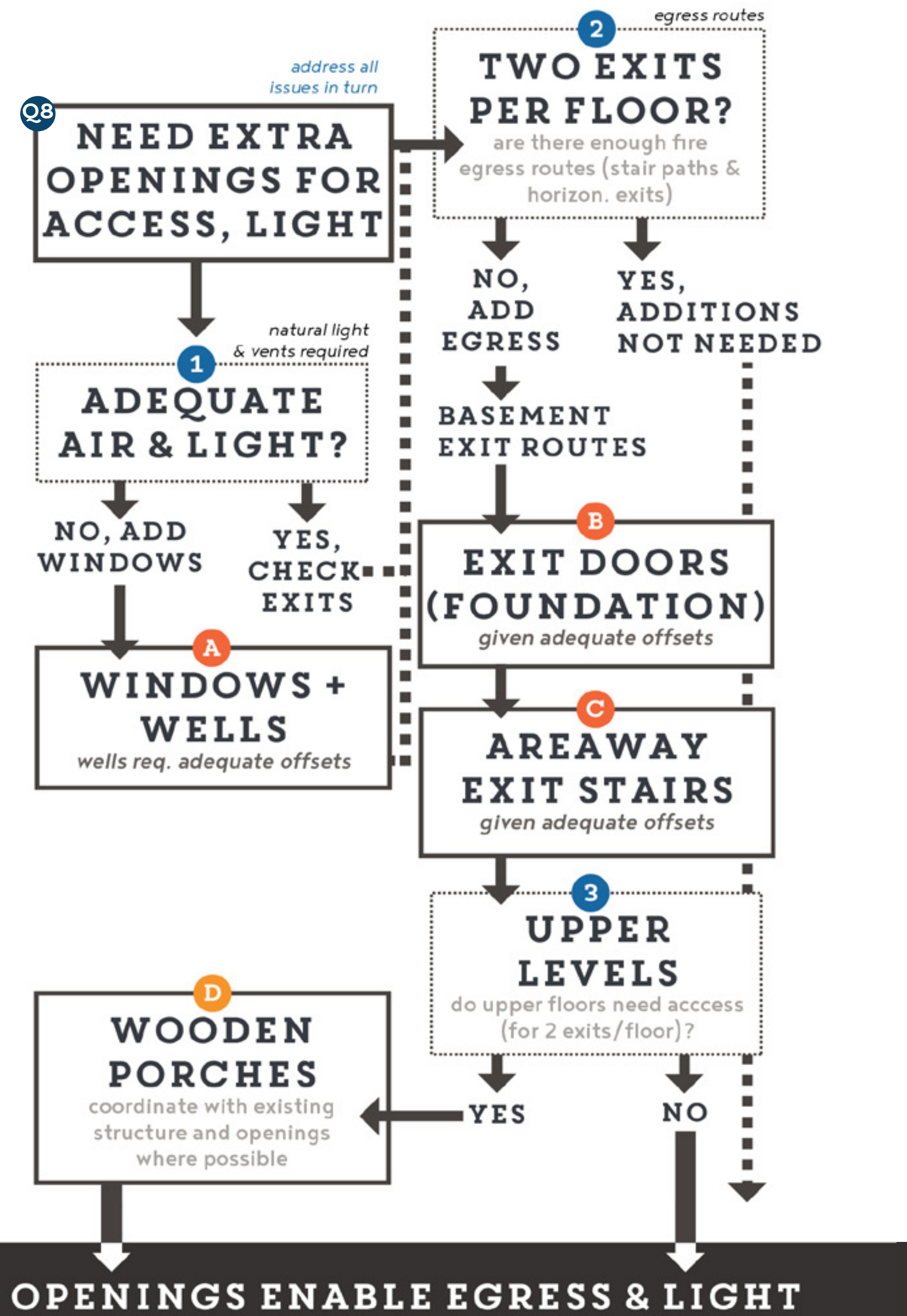
- **A** main service connection, perpendicular to street
- **B** shut-off valve on riser pipe
- **C** regulator (pressure control) and relief vent
- **D** meters w/in 4' of building corner (>3' to electric, no windows above)
- **E** expansion areas (for new meters)
- **F** 2', ground to meter top
- **G** lock valve (for control of individual meters)
- **H** meter itself
- **I** gas pipe to interior
- **J** customer shut-off valve, on rigid steel pipe, clamped along wall/joists
- **K** rigid steel gas line–2 segments shown with lateral connection
- **L** safety shut-off valve per connected fixture
- **M** line coupling, nuts at connection ends (female)
- **N** threaded connectors (male)–sized to maintain req. flow capacity to appliance (typ. 1/2")
- **O** stainless steel connection
- **P** gas fixture/appliance

EXITS/OPENINGS . light . access stairs

Reference: Elements & Installations

- **A1** basement window with short, corrugated light well
- **A2** basement window from interior, with deeper cmu light well
- **B** basement exit (short) with thin metal lintel at sill (during construction)
- **C1** new entryway, with CMU in place– before grouting or pour of stairs
- **C2** finished stair with drain in 3' entry landing, handrail at stair
- **D** typ. external stairs with structure tied to building and supported on piers

General Note: Stairs, as in D, or a porch roof should be built over new areaways, in addition to insulating exterior walls. The overhead protection creates a microclimate which collects heat escaping from the building. This heat keeps the area around the foundation and old footers (no longer insulated by soil) from experiencing frost heave and thus limits foundation movement, cracks, and structural damage.



ACCESS/EGRESS APPROACHES:

Your addition of new exits and window openings will be determined by code and 1) the vertical space and lateral offsets limiting window and wells dimensions as well as 2) placement of 80" tall doors and egress areaways, landings, and steps. As multi-units must have two exits per floor, single family conversions 3) need a rear fire-escape for upper floor travel paths.

1. Light & Windows–height and lateral space for wells: Your architect will advise on the available wall and lot space required to meet code requirements for light. Given foundation loading, it often makes more sense to dig window wells, if you have the space, than to have larger horizontal spanning lintels. The area of openings, on building sides, will be limited by allowed open areas according to fire code.

2. Egress Doors–floor height and clear passage/step limits As with windows, your architect will advise on placement and elevation in coordination with structure and thermal envelope, as well as aligning with areaways/landings, exterior drains, and clear passage/step requirements. Entry and exit areaways within a property's off-sets will require an administrative adjustment for zoning.

3. Egress areaways–offsets, landings, and step requirements: Your architect will advise on exit areaways and/or landing locations as determined by site-offsets and the coordination between stair parameters, elevation to ascend, and exterior drainage systems.

4. Egress upper level–porches: Your architect will advise on placement of new porches, typ. aligning stair paths to reach/enlarge windows to doors and bridge from building structure to pier/footings aligned with planned retention and drainage systems. Your overall placement will be limited by rear-offset and open space requirements.

MITIGATION COORDINATION:

A. WINDOW ADDITIONS (+ WELLS)

Based on site area, you may be able to add window wells and taller windows to meet your light & air requirements. If not, you can add shorter windows (within structural reason, as advised by your architect).

Related construction required:

- coordinate flashing and sealing of frames to continue vapor barriers & thermal envelope req. for drainage & radon protection
- coordinate well drainage with foundation drainage
- coordinate lintels/height with any sill/anchoring work
- coordinate area with fire code (3-15' offsets = 15-45% openings with fire-resistant materials)

B. EXIT DOORS AT AREAWAY

Direct exits help satisfy fire code (two exits per floor) and their structure is fairly simple. Key element to coordinate is matching elevation/height with existing sills (top) and areaway drainage (bottom).

Related construction required:

- see all the remarks under 'A. window additions'
- a single step, under 8" high, is allowed on interior side of exit-use to increase height and avoid flooding (if areaway drains fail)
- coordinate with 'C. landings, areaways, stairs' (below)
- add roof for thermal protection if lacking 'D. fire-escape' (below)

C. LANDINGS, AREAWAYS, STAIRS

A second exterior stair/areaway addition is common for Cottage conversions, as it eliminates the need for an interior stair and hallway.

Related construction required:

- coordinate retention walls and drains with drainage
- coordinate placement with new doors and existing walkways

D. UPPER LEVEL PORCHES

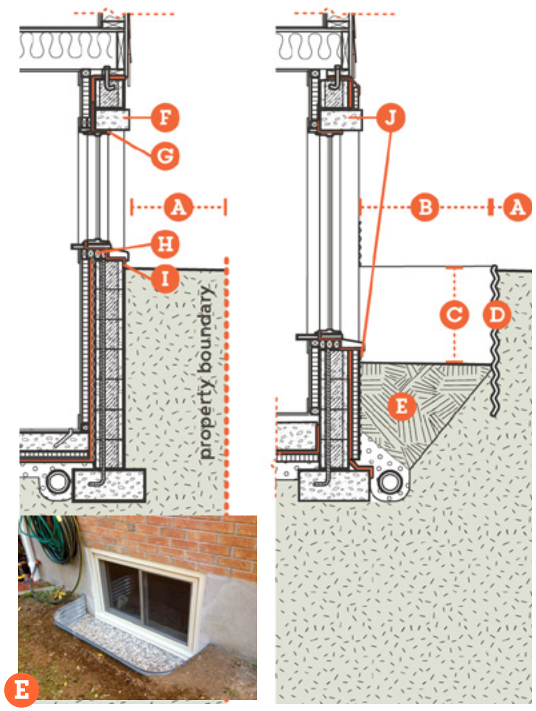
A porch addition is common for single family conversions, as code requires two exits per floor (no matter the associated unit).

Related construction required:

- coordinate structure with building frame, existing porches/stairs
- coordinate foundations with other site walls and drainage

A. WINDOW ENLARGEMENT + WELLS

common window profiles
with and without space for wells, drainage areas



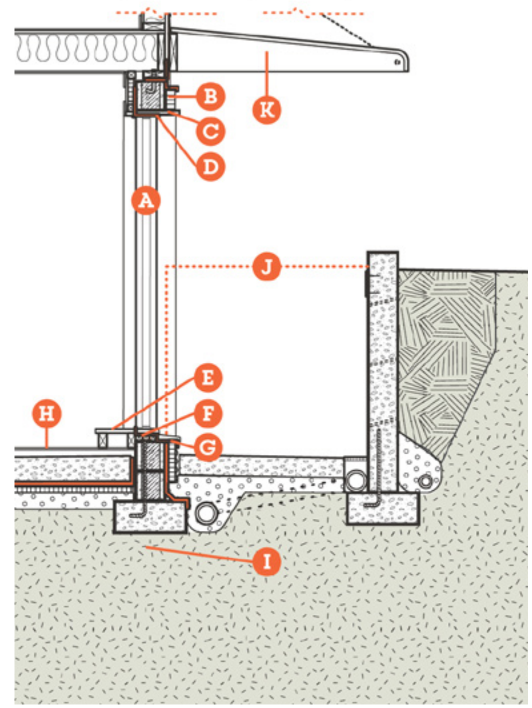
- **A** <=2' from property edge
- **B** 3' wide window well
- **C** 2' deep window well (by 1:1.5 ratio in code)
- **D** corrugated retention edge
- **E** gravel drains to drainage system/sump pump
- **F** lintel (bridges foundation opening, depth varies by material)
- **G** flashing above frame
- **H** window & frame sit on foundation wall, min. 6" above adj. ground
- **I** flashing below bottom sill & drip area (to prevent leaks, extend barriers & keep continuous enclosure)
- **J** same system for tall or short windows

$300-$1,000 **window** **$2,500+** **egress window & well**

Windows–for light and air–can be added to your foundation as long as there is adequate structural support or bridging of openings with reinforced lintels. It is important that a) flashing and sealing around the frame maintains the air, water, and thermal barriers of your radon and drainage system and thus b) provides continuity of fire resistance/protection. All window wells should be integrated with your foundation drainage, through basins or free draining materials like gravel. Costs vary by fixture, foundation alterations, and retention/soil work at wells.

B. EXIT DOORS AT AREAWAY

common exit profile
notes on adapted surface exposure, height issues



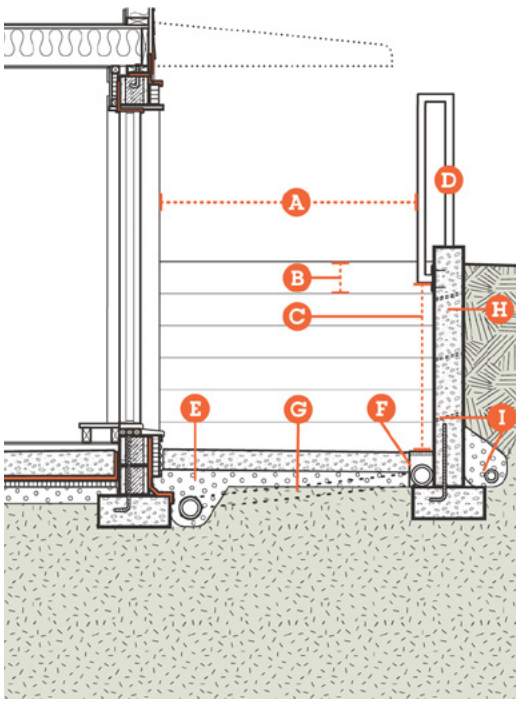
- **A** 2" door (fire req.)
- **B** foundation, with ext. insulation (taller spaces)
- **C** lintel, variable depth
- **D** flashing above frame
- **E** 1 step to mediate height, 8" max
- **F** frame rests on foundation wall (see window notes)
- **G** flashing below (see window notes)
- **H** finished interior height
- **I** soils around footers, less insulated than before
- **J** soil volume removed (lost insulation)
- **K** porch awning (or fire-escape) above to create microclimate and trap heat to stabilize footer, limit frost heave

$600-$800 **per door (without excavation)**

All thermal, structural, and fire resistance aspects of windows equally apply to door openings. In addition, anywhere you're exposing foundation walls you should make sure to add insulation and enclosure like a porch awning to avoid thermal shock and frost heave impacting your foundation/footing structures. See areaways, right, for comments on steps and drainage. Fire door costs are fairly stable; surrounding work (areaway, foundation cuts) will determine price.

C. LANDINGS, AREAWAYS, & STAIRS

areaway stairs additions - in ground
notes on clear passage and stair parameters



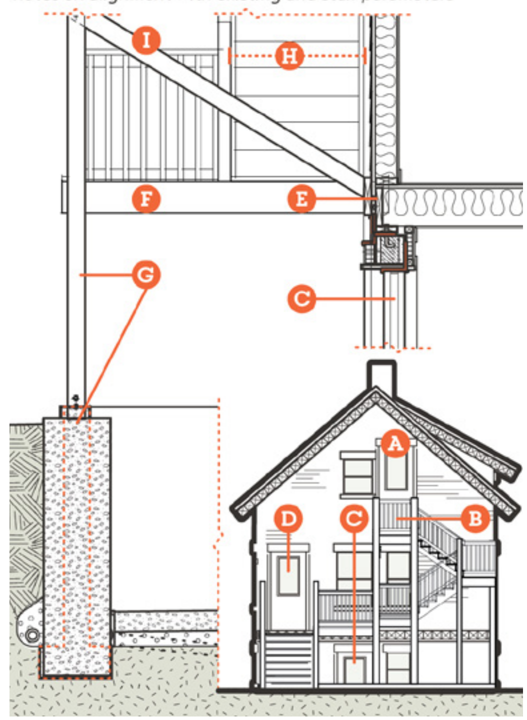
- **A** min 36" egress clearance (72" here, stair alignment)
- **B** 8" max step height, 9" max depth
- **C** 34-36" railing at stairs
- **D** 42" to landing/grade railings
- **E** drainage beneath areaway/in gravel (see tile drains)
- **F G** connects to trench drains
- **H** retaining walls (CMU, concrete, etc.)
- **I** weep holes and base pvc pipe (connects to drains)

$1,500-$2,200 per areaway,
$1,500-$3,000 stairs

Exterior areaways and stairs should be incorporated to meet egress requirements. Landings must be 3' x 3' min, with no more than 1 step up from any interior passage. Coordinate door height and areaway drainage to avoid flooding. 34-36" railings at stairs, 42" ailings at landings, and 36" clear passages are required but enlarge as needed to work with other egress. Cost varies by size of area, drainage, and excavation.

D. UPPER LEVEL PORCHES

external porch additions - upper floors
notes on alignment with existing and stair parameters

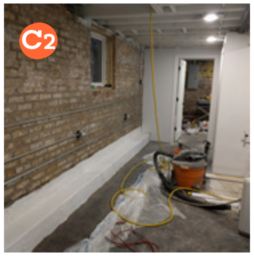


- **A** new second floor exit
- **B** overall porch structure
- **C** basement exit, covered areaway
- **D** 1st floor exit, porch steps
- **E** header anchored to exterior building fire wall
- **F** landing joist (hung at headers, bolted to piers)
- **G** vertical posts (3' min) depth coord. w/ walls
- **H** min 36" stairs, 42" railings
- **I** diagonal bracing (higher than shown for passage)

$1,500-$3,000 per level

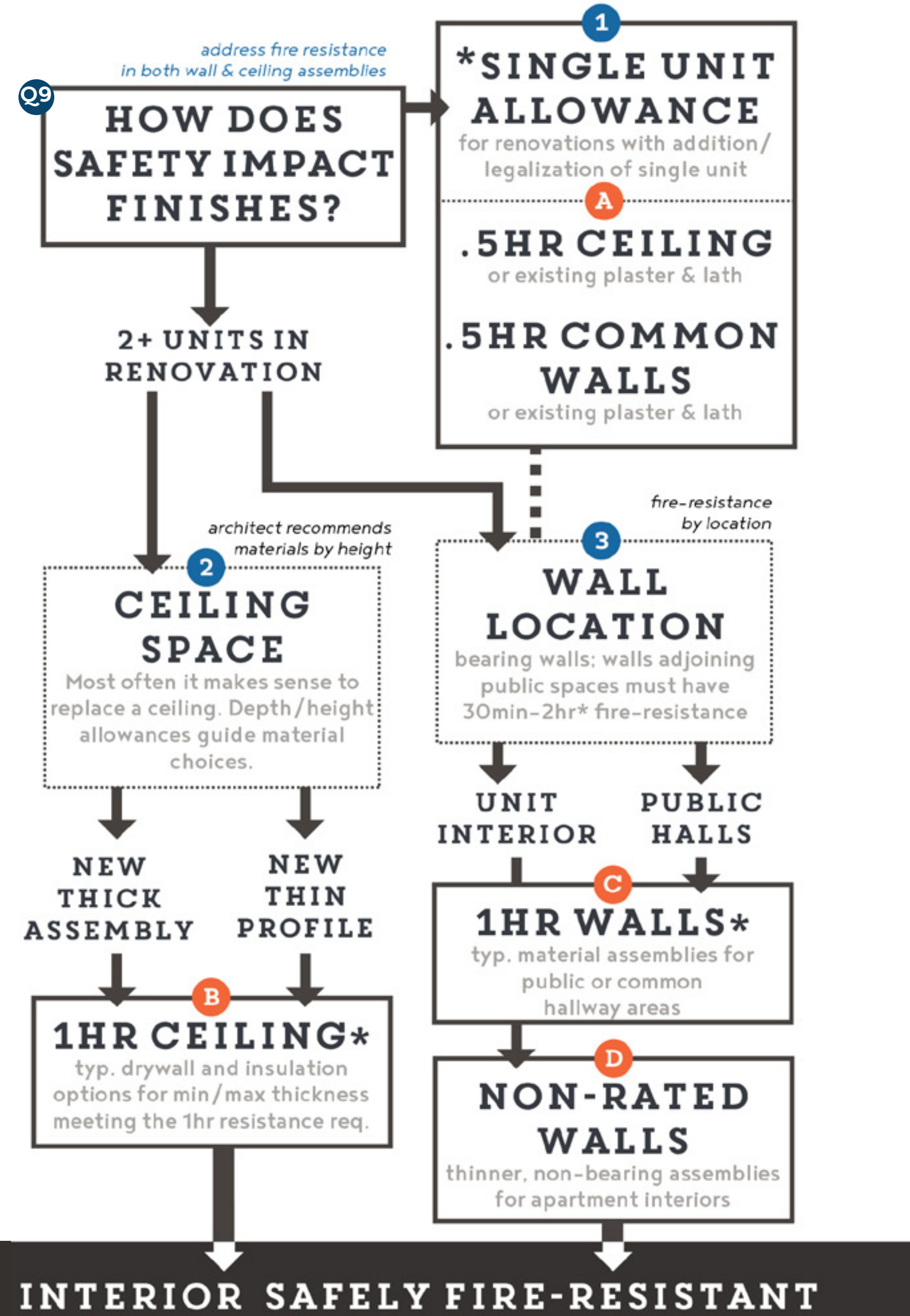
Landings must be 3' x 3' min, with steps no > 8" high and < 9" deep. Systems can be free standing structures or attached to protected exterior walls (pref. brick, concrete, or CMU). Fire-retardant wood and/or heavy timber structures are safer and allow more flexibility in placement, size/area along perimeter (over 50%), and can incorporate decks (up to 150sqft/unit). Costs will vary by system size and complexity.

FINISHES . fire partitions . internal walls



Reference: Elements & Installations

- **A** gypsum board installation on joists (second layer to be perpendicular)
- **B1** mineral wool with framing
- **B2** dual gypsum layers (Type X fire resistant) on wood frame
- **C1** rigid foundation insulation and vapor barriers behind finishing frame
- **C2** exposed brick foundation-repointed brick, electric in conduits on surface
- **D** typical exposed 2x4 frame, note framing around ducts, overhead electric, fire-blocking in end walls



FINISHING APPROACHES:

Your basement unit will incorporate common wall assemblies (next page), with location and foundation material dictating the degree of fire-resistance necessary (0-2hr). Those burn-time requirements necessitate different materials/thicknesses for framing, drywall, insulation, and treatment of openings. Understanding those differences and your overall room count can help you estimate finishing costs.

1. *Renovations with a Single Unit Addition-.5hr partitions: For renovations that add (or legalize) a single unit, ceiling and common wall burn time are reduced to 30 minutes or, if original surfaces are present, the existing resistance of plaster and lath walls/ceilings. (14R-3-309.1) Additional units result in all areas (ceiling, common walls) reverting to 1hr fire-resistances of 2 and 3 below. For the unit's interior walls see D.

2. Ceiling-1hr fire partition*: Your architect will advise on your specific ceiling assembly, given ductwork and height requirements. Typical new and archaic assemblies are shown with ductwork. Diagram shows where resistance is measured from when estimating burn-times.

3. Common Area Walls-1hr fire partition*: As with the ceiling, your architect will advise on specific assemblies. Drawing shows typical frame walls of different thickness-5 ½" to 4"-that take advantage of fire-resistant gypsum, mineral insulation, and pressure-treated, fire retardant wood.

D. Interior Unit Walls-non-rated: Your architect will advise on specific room assemblies, as interior unit walls do not have req. resistance. Exposed framing is shown so you are familiar with basic wall structure.

MITIGATION COORDINATION:

A. *SINGLE UNIT ALLOWANCE - .5HR

Single unit additions, when renovating a building, are premitted to reuse intact plaster and lath or use new 30 minute partitions on ceilings and common walls. The annotations next page list alternate materials/thicknesses relative to profiles in B and C.

Related construction required:

- see note on coordination in B and C below.

B. CEILING AS 1HR FIRE PARTITION*

All new ceilings (for two + units) should be 1hr fire-resistant assemblies to keep fire from climbing up the structure. More generally, elements like fire stops (in D. non-rated walls), blocking between joists (at top plate connections) and mineral insulation enclose and cellularize air-space within the wall, so the frame does not act as an open chimney.

Related construction required:

- coordinate with electric, ventilation, overhead plumbing, and all joist/beam repairs

C. WALLS AS 1HR FIRE PARTITION*

New walls (for two + units) between common areas and units must be 1hr assemblies, in order to protect passage along fire egress routes. Measured from either side, these assemblies can be symmetrical, as shown, or mix equivalent 1hr drywall, panel, and attachment assemblies.

Related construction required:

- coordinate with any in-wall plumbing, electric, or vents.
- partition placement overall should be coordinated between egress route reqs., openings, and unit size reqs.

D. NON-RATED WALLS (INTERIOR)

Interior unit walls, if not bearing weight, do not have resistance requirements. Drawing of frame is to show overall elements & structure.

Related construction required:

- coordinate thickness with plumbing, electric, and vent needs.
- coordinate layout/openings with room size and egress needs.

A. SINGLE UNIT ALLOWANCE - .5HR

CEILING ALTS. (B)

Existing components (unchanged/indeterminate) not incorporated in calculation of fire resistance.

- **A** indeterminate
- **B** unchanged
- **C** indeterminate
- **D** unchanged
- **E** 5/8" gypsum (or 1/2" + 3/8" if patching and layering) - 30 minutes.
- **F** varies
- **G** indeterminate
- **H** indeterminate, but should approximate lath in B.2
- **I** indeterminate, but should approximate plaster in B.2

WALL ALTS. (C)

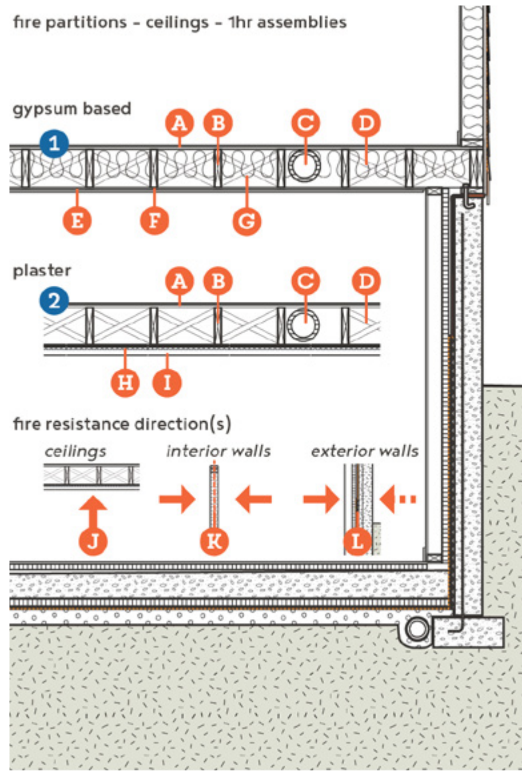
Existing components (unchanged/indeterminate) not incorporated in calculation. Alts. focus on single wall side.

- **A** unchanged
- **B** unchanged
- **C** 2 layers of 1/2" gypsum
- **D** drywall nails 8" o.c.
- **E** Unlikely to find robust frame and/or internal insulation. See alts for gypsum and thin wall types (C.1, C.3).
- **J** unchanged
- **K** unchanged
- **L** 5/8" Type X gypsum
- **M** cement coated nails 7" o.c.

COST VARIES, see B & C

The reduced partition requirement should accomodate incorporation of existing assemblies (like the structurally sound flooring and joists of your 1st floor unit or the frames and plaster on current utility room walls) in combination with new gypsum or intact lath & plaster surface. As you can focus on a single side of the assembly only (vs. both sides of a wall) to meet code, this should reduce the costs/labor of finishing. Your architect/engineer/builing official will be able to inspect existing materials and calculate additional resistance needed (14B-7-722).

B. CEILING AS 1HR FIRE



- **A** double wood floor (15/32" sheathing ply + finished)
- **B** joists: 16" on center spacing (o.c.) (depth varies by span)
- **C** 6" insulated ducts
- **D** cross braces (in all)
- **E** 1/2" Type X gypsum (if 24" o.c.use 2 layers 5/8")
- **F** drywall screws at 6" o.c.
- **G** mineral wool (adds 15 min)
- **H** 3/8" Type X gypsum lath (perpendicular to joists)
- **I** 1/2" gypsum plaster

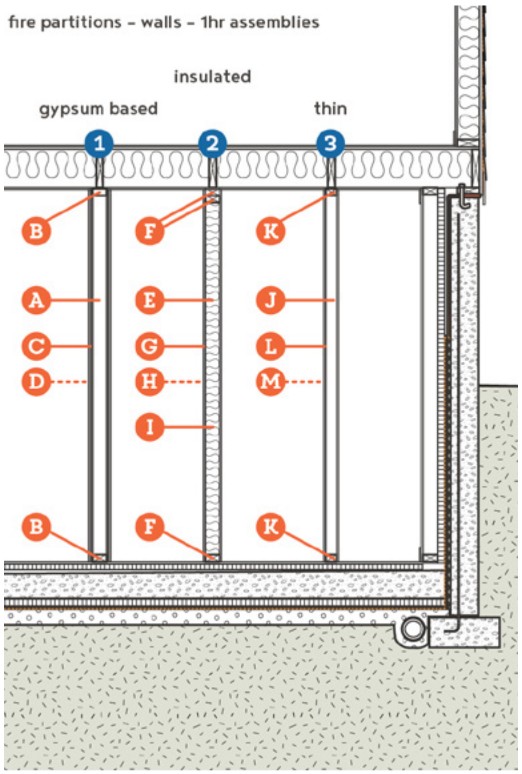
resistance measured from likely fire direction

- **J** ceiling: from below
- **K** walls: both side, symmetrical
- **L** exterior: both sides under 10', interior only over 10' offset

$4,200-$5,200 drywall & painting

For ceilings, you should have continuous enclosure between floors in your 1hr fire partition materials, with minimal openings for stairways and egress connections. In addition ducts should be insulated and each unit, if using forced air, should have it's own ventilation systems to avoid fire jumping between ducts. Mineral wool insulation may be incorporated for additional fire resistance and thermal efficiency. Talk with an acoustical professional about dampening sound. Costs vary by ceiling areas to be patched or replaced.

C. WALLS AS 1HR FIRE PARTITIONS

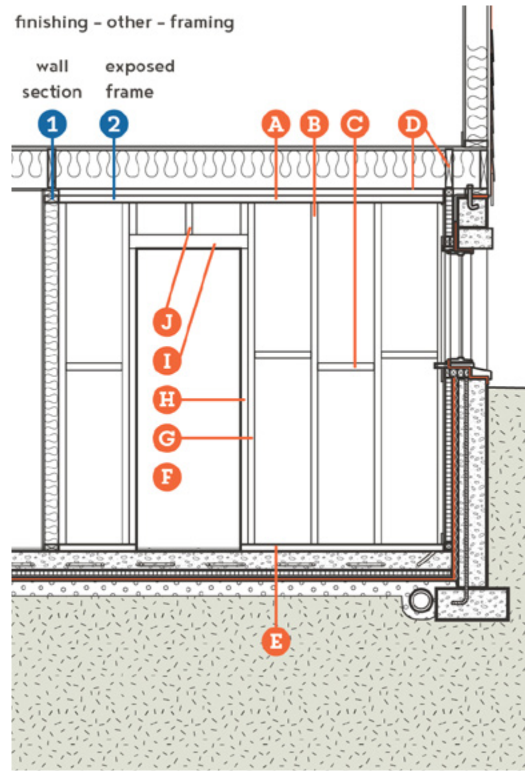


- **A** 2x4 wood stud, 16" o.c.
- **B** single top/bottom plates
- **C** 2 layers of 3/8" gypsum
- **D** drywall nails 8" o.c.
- **E** 2x4 wood stud, 16" o.c. (varies with steel studs)
- **F** double top + bottom plate
- **G** 5/8" Type X gypsum + sheathing
- **H** Type S drywall screws 1' o.c.
- **I** mineral wool insulation
- **J** 2x3 fire-retardant studs, 24" o.c.
- **K** single top/bottom plates
- **L** 5/8" Type X gypsum
- **M** cement coated nails 7" o.c.

$6,000-$11,000 **partition walls for entire unit**

Fire partitions, along egress hallways, can be very simple structures of minimal width, 4-5.5". Double layer, Type X gypsum is relatively inexpensive compared to the costs of mineral wool or fire retardant wood studs. Your architect can elaborate on the gypsum and insulation options to be used in combination with steel studs. Assemblies also typically include fire-blocking and hallway outlets, lights, and smoke detectors.

D. NON-RATED WALLS (INTERIOR)



- **A** double top plates
- **B** 2x4 stud, 16" o.c.
- **C** fire-blocking (minimized continuous air pockets)
- **D** attach to joist or blocking
- **E** bottom plate, anchor
- **F** door opening
- **G** king stud
- **H** jack stud
- **I** headers (to match stud depth
- **J** cripple stud

$6,500-$13,500 **drywall/interior walls overall**
$2,400-$5,450 **finishing per room–bed/dining/living**
$6,250-$12,000 **kitchen**, **$4,000- $7,800** **bath**

Inner unit walls are not required to be fire resistant. That said you might consider adding insulation or thicker gypsum for thermal performance. The above provides a general schema of the internal structure within your walls. Wall and finishing costs will vary by area and complexity of room/ duct enclosures and fixtures (kitchen/bath).

SCENARIO: COTTAGE . major project . one to two units

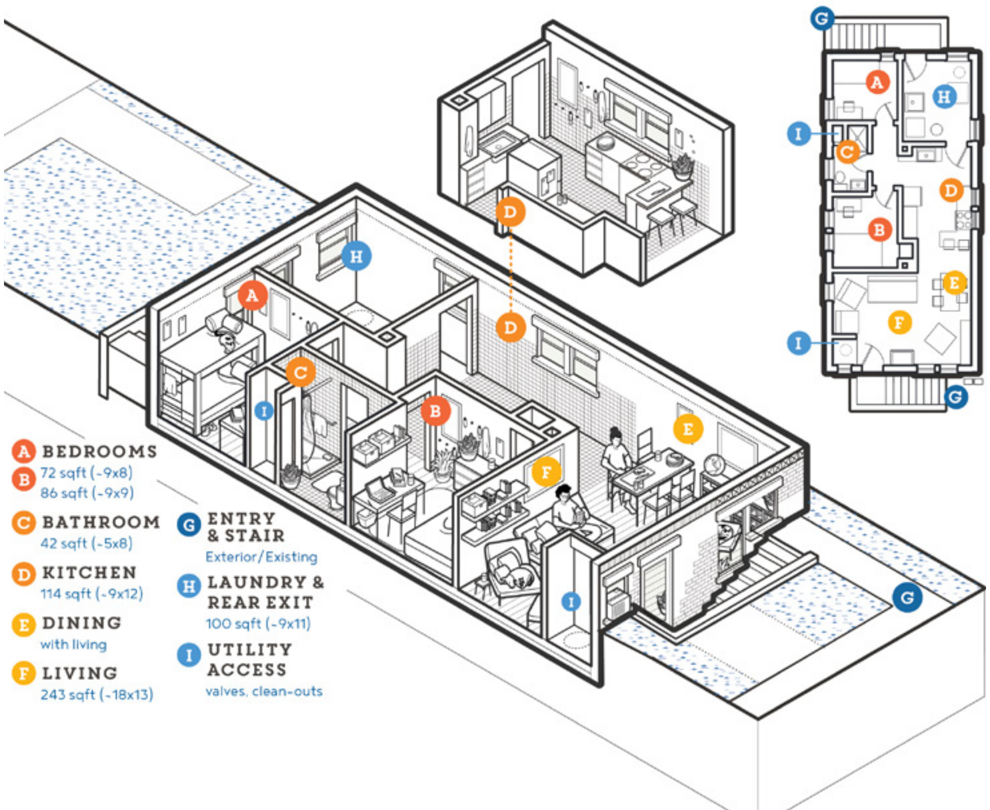
CONVERSION ASSUMPTIONS:

This Cottage conversion creates a 633 sqft, two bedroom basement apartment. It offers a good example of a larger adaption, which is necessary to convert an older single family home to a multi-unit building.

It consists of:

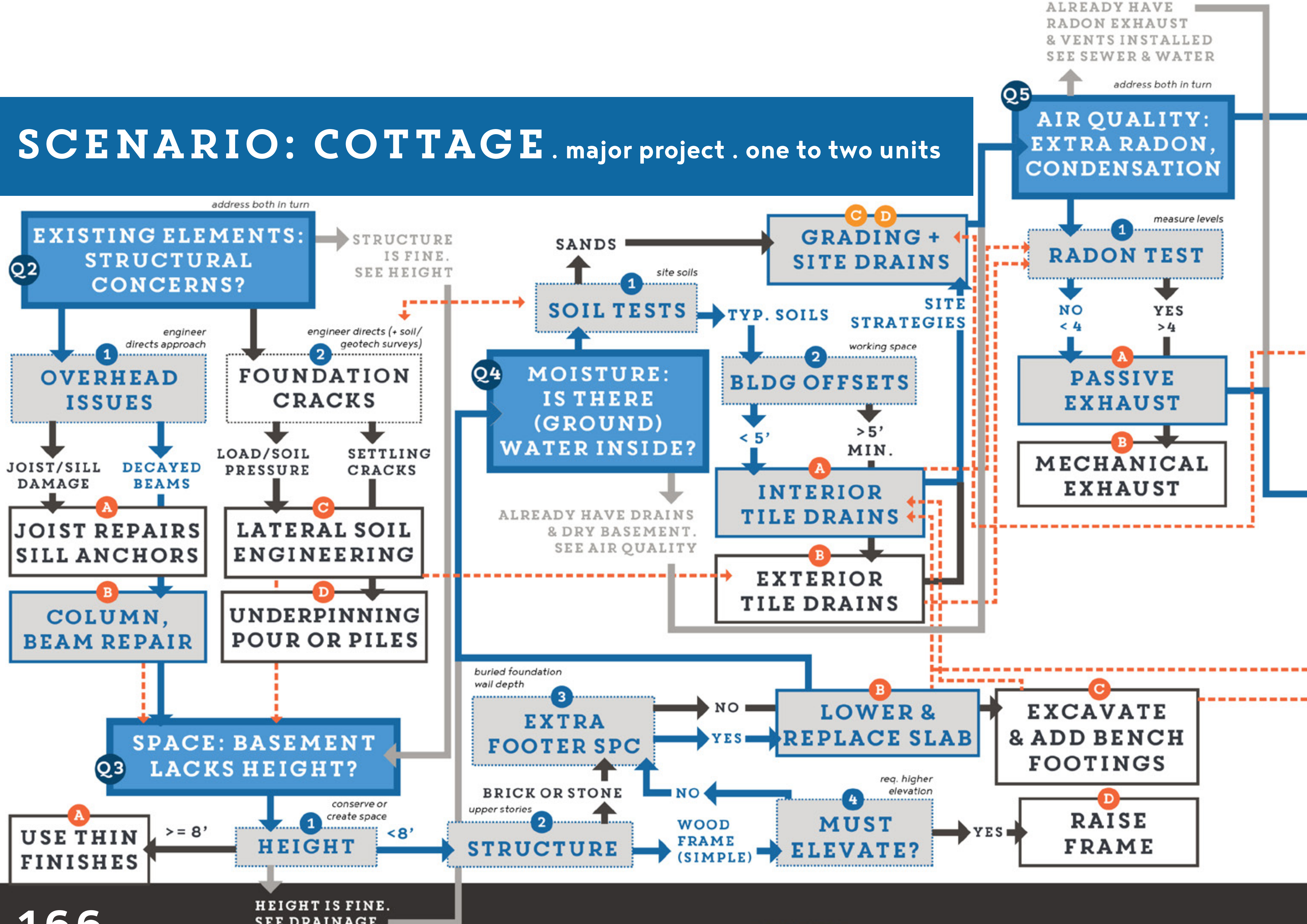
1. **construction preparation:** safe lead and asbestos removals in advance of construction, plus basic permits
2. **structural work:** old beam spanning between small chimney cores needs to be replaced to support joists
3. **height/slab work:** unlikely to have an adequately thick slab, lower floor level as much as possible (without excavation) and use thin tile floors
4. **drainage:** small lot requires the installation of interior drainage and sump pump, integrate with newly created areaway drains; sump pump is piped to rear yard for infiltration
5. **air quality:** vapor barriers and exhaust need to be added (with slab), heat & duct work should be added (from common area at rear) for fresh air, directly vent bath fans to the exterior
6. **water/sewer:** resized water line is necessary for new fixtures, basement sewer lines are connected to a new, larger ejector pump which meets the service line near front entry
7. **electric/gas:** gas separated for water heater, furnace use. full house replacement of old electric as well as new unit lines.
8. **exits/openings:** addition of front door and entry stairway, addition of fire-escape for 2nd floor.
9. **finishing/fire-resistance:** minimal wall partitions, full replacement of ceiling partition and full apartment worth of drywall, paint, doors, and trim.

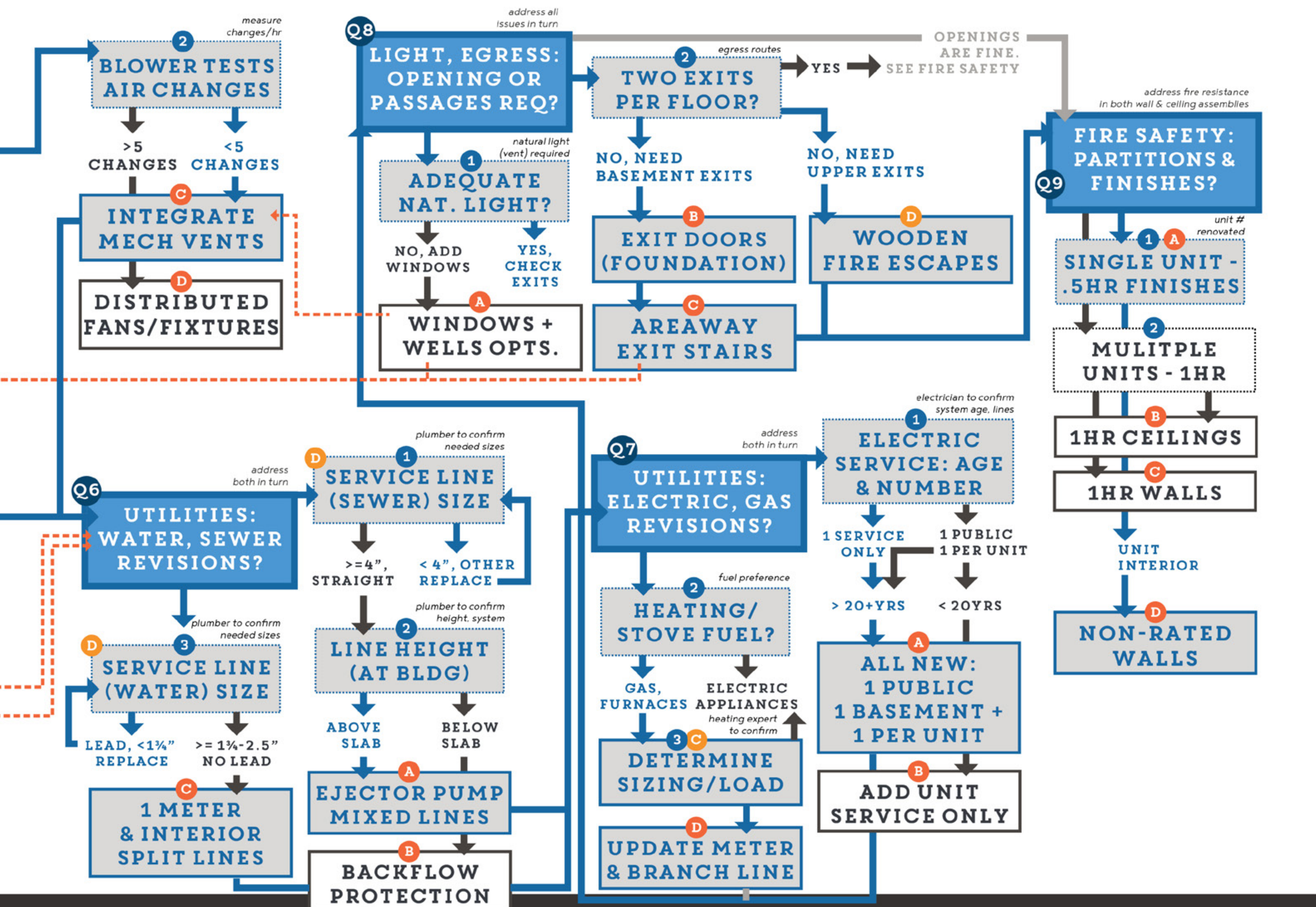
COMMON CONVERSIONS, PAGE 41



Estimate of Work: Cottage, Two-Bedroom Unit Conversion			
City Permits	low	mid	high
Q1 Overall Building Permits	$ 4,000.00	$ 4,500.00	$ 6,750.00
(permit specific fees)			
Lead Clearance	$ 300.00	$ 400.00	$ 500.00
Asbestos Testing	$ 300.00	$ 300.00	$ 450.00
General Demolition Costs			
none required			
Site - Drainage, Passages, General Work			
Q4 New surface sidewalks	$ 800.00	$ 1,720.00	$ 1,800.00
Area drains around site	$ 1,280.00	$ 1,600.00	$ 2,300.00
Q8 New concrete areaway at entry	$ 1,650.00	$ 2,160.00	$ 2,200.00
Window Replacement			
Operable Windows (4 new, 600-1800 each)	$ 2,400.00	$ 4,800.00	$ 7,200.00
Doors & Exits			
New metal entry door (door, opening)	$ 575.00	$ 600.00	$ 780.00
Interior, main structure			
Structure & Loading			
Q2 Main beam replacement (center columns, girde	$ 3,900.00	$ 5,500.00	$ 6,480.00
Slab, Waterpoofing & Vapor Barriers			
Q3 Slab replacement	$ 2,600.00	$ 10,000.00	$ 11,300.00
Barriers & Drainage/Sump System			
Q3 Air seal envelope (w/ slab patching)	$ 2,700.00	$ 6,000.00	$ 7,150.00
Drainage plane and foam insulation (for full slab	$ 3,400.00	$ 3,500.00	$ 6,200.00
Q5 Sump pump and tiles (full perimeter system)	$ 5,950.00	$ 8,900.00	$ 10,200.00
Utility connections & lines			
Gas			
Q7 New gas line interior piping	$ 700.00	$ 980.00	$ 1,800.00
Water			
New water supply - service connection	$ 15,800.00	$ 18,000.00	$ 21,500.00
Q6 Interior water pipes	$ 3,500.00	$ 4,800.00	$ 5,250.00
Sewage and Ejector Pump			
Q6 Interior horizontal lines for waste & venting	$ 4,200.00	$ 4,500.00	$ 4,900.00
Ejector pump added	$ 1,750.00	$ 2,100.00	$ 7,050.00
Electric			
Q7 rewire new and old units, line addition	$ 19,800.00	$ 31,400.00	$ 33,200.00
Ventilation & Plumbing Fixtures			
Heating and Centralized Ventilation			
Q5 Basement furnace and ductwork (full house)	$ 8,000.00	$ 9,400.00	$ 10,200.00
Radon Exhaust - active (retrofit to new piping)	$ 500.00	$ 1,500.00	$ 2,500.00
Revised Laundry Facilities			
New hot water tank	$ 675.00	$ 1,350.00	$ 1,600.00
New Laundry hook ups & tub	$ 775.00	$ 900.00	$ 1,475.00
Kitchen (default fixtures)			
Kitchen sink	$ 250.00	$ 300.00	$ 380.00
light over sink	$ 120.00	$ 180.00	$ 350.00
Q5 range hood	$ 345.00	$ 375.00	$ 550.00
Bath (default fixtures)			
plumbing fixtures	$ 1,195.00	$ 1,700.00	$ 2,300.00
lav light	$ 120.00	$ 180.00	$ 350.00
Q5 exhaust fan	$ 325.00	$ 400.00	$ 650.00
Egress & Unit Access (see also exterior)			
Q8 new interior stair (approx. cost/story exterior)	$ 1,550.00	$ 1,600.00	$ 3,350.00
Interior finishes & Fire Partitions			
Q9 **Ceilings**			
plaster ceiling (1hr partition)	$ 1,400.00	$ 2,600.00	$ 4,100.00
paint ceiling	$ 700.00	$ 975.00	$ 1,100.00
Q9 **Walls**			
partition walls - wooden studs	$ 6,300.00	$ 6,400.00	$ 11,500.00
drywall 1/2" (interior)	$ 6,500.00	$ 8,080.00	$ 13,500.00
drywall 5/8" (1hr fire partition)	$ 3,500.00	$ 4,250.00	$ 5,200.00
Finishing costs by rooms			
see 'Building Equity' for room by room estimate	low	medium	high
Project Sums	$ 126,065.00	$ 175,820.00	$ 230,555.00

SCENARIO: COTTAGE . major project . one to two units




measure changes/hr
2
BLOWER TESTS AIR CHANGES
>5 CHANGES
<5 CHANGES
C
INTEGRATE MECH VENTS
D
DISTRIBUTED FANS/FIXTURES
Q8
address all issues in turn
LIGHT, EGRESS: OPENING OR PASSAGES REQ?
natural light (vent) required
1
ADEQUATE NAT. LIGHT?
NO, ADD WINDOWS
YES, CHECK EXITS
A
WINDOWS + WELLS OPTS.
egress routes
2
TWO EXITS PER FLOOR?
YES
OPENINGS ARE FINE. SEE FIRE SAFETY
NO, NEED BASEMENT EXITS
NO, NEED UPPER EXITS
B
EXIT DOORS (FOUNDATION)
C
AREAWAY EXIT STAIRS
D
WOODEN FIRE ESCAPES
address fire resistance in both wall & ceiling assemblies
Q9
FIRE SAFETY: PARTITIONS & FINISHES?
unit # renovated
1 A
SINGLE UNIT - .5HR FINISHES
2
MULITPLE UNITS - 1HR
B
1HR CEILINGS
C
1HR WALLS
UNIT INTERIOR
D
NON-RATED WALLS
Q6
address both in turn
UTILITIES: WATER, SEWER REVISIONS?
plumber to confirm needed sizes
D 3
SERVICE LINE (WATER) SIZE
LEAD, <1¾" REPLACE
>= 1¾-2.5" NO LEAD
C
1 METER & INTERIOR SPLIT LINES
plumber to confirm needed sizes
D 1
SERVICE LINE (SEWER) SIZE
>=4", STRAIGHT
< 4", OTHER REPLACE
plumber to confirm height, system
2
LINE HEIGHT (AT BLDG)
ABOVE SLAB
BELOW SLAB
A
EJECTOR PUMP MIXED LINES
B
BACKFLOW PROTECTION
Q7
address both in turn
UTILITIES: ELECTRIC, GAS REVISIONS?
fuel preference
2
HEATING/ STOVE FUEL?
GAS, FURNACES
ELECTRIC APPLIANCES
heating expert to confirm
3 C
DETERMINE SIZING/LOAD
D
UPDATE METER & BRANCH LINE
electrician to confirm system age, lines
1
ELECTRIC SERVICE: AGE & NUMBER
1 SERVICE ONLY
1 PUBLIC 1 PER UNIT
> 20+YRS
< 20YRS
A
ALL NEW: 1 PUBLIC 1 BASEMENT + 1 PER UNIT
B
ADD UNIT SERVICE ONLY

SCENARIO: TWO-FLAT . medium . two to three units

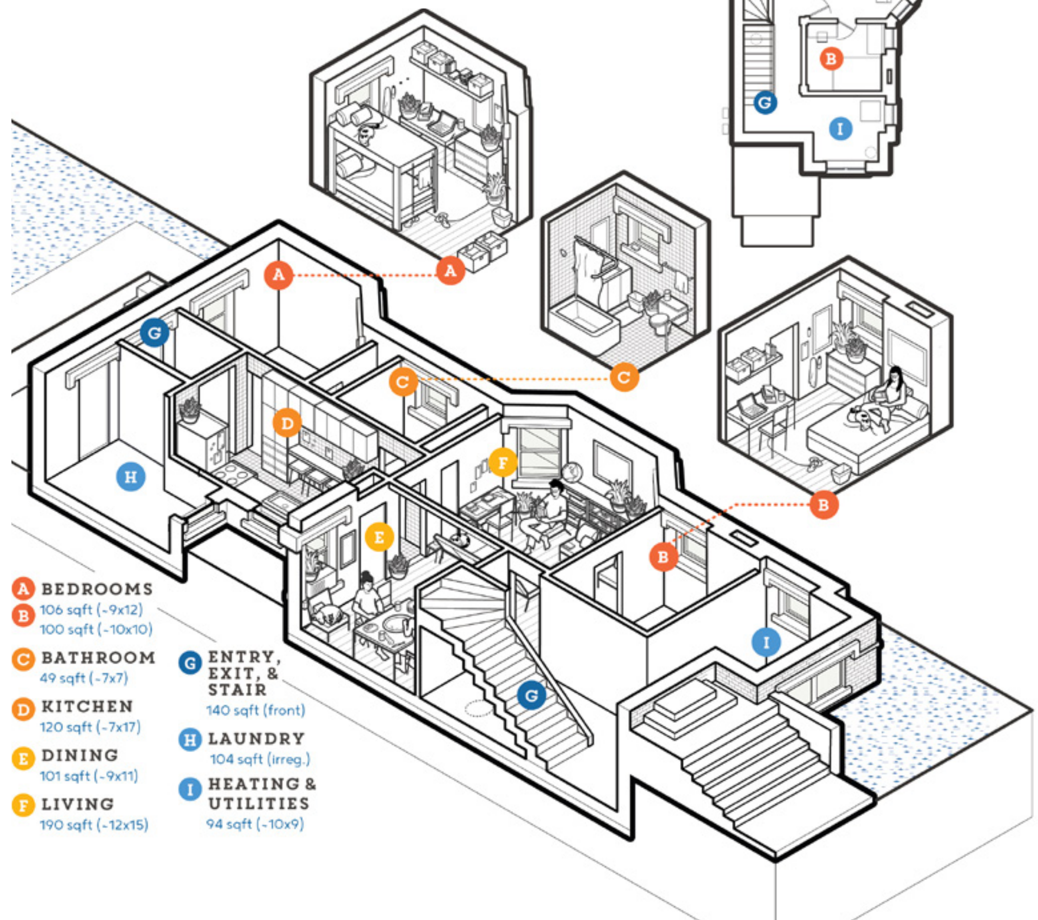
CONVERSION ASSUMPTIONS:

This Two-Flat conversion creates a 720 sqft, two bedroom basement apartment. It offers a good example of a small-mid-sized budget which is necessary for adding another unit to a multi-unit building.

It consists of:

1. **construction preparation:** safe lead removal in advance of construction, plus basic permits
2. **no structural work:** brick walls (above) are likely to have original steel spanning beams and columns
3. **height/slab work:** height is fine, slab will need patching and resealing of existing barriers during drainage and sewage work
4. **drainage:** larger lot and offset allow for exterior drainage and sump pump, excess slab drains removed, and sump pump connected to front storm system for disposal
5. **air quality:** likely to have passive radon exhaust at front, minor fans for fresh air, directly vent bath/kitchen to the exterior
6. **water/sewer:** water service line is adequate to fixtures, basement sewer lines are connected to a new, larger ejector pump which meets the service line in the common front area
7. **electric/gas:** gas connection is fine. only gas work is adjusted furnace lines; uses electric cooking; electric is only added to the new unit; existing public and upper units' lines are fine.
8. **exits/openings:** no additional stairs or fire-escapes are necessary. Laundry door is enlarged from existing window.
9. **finishing/fire-resistance:** larger fire partitions added at front and rear common areas, some replacement of ceiling plaster and full apartment worth of drywall, paint, doors, and trim.

COMMON CONVERSIONS, PAGE 34



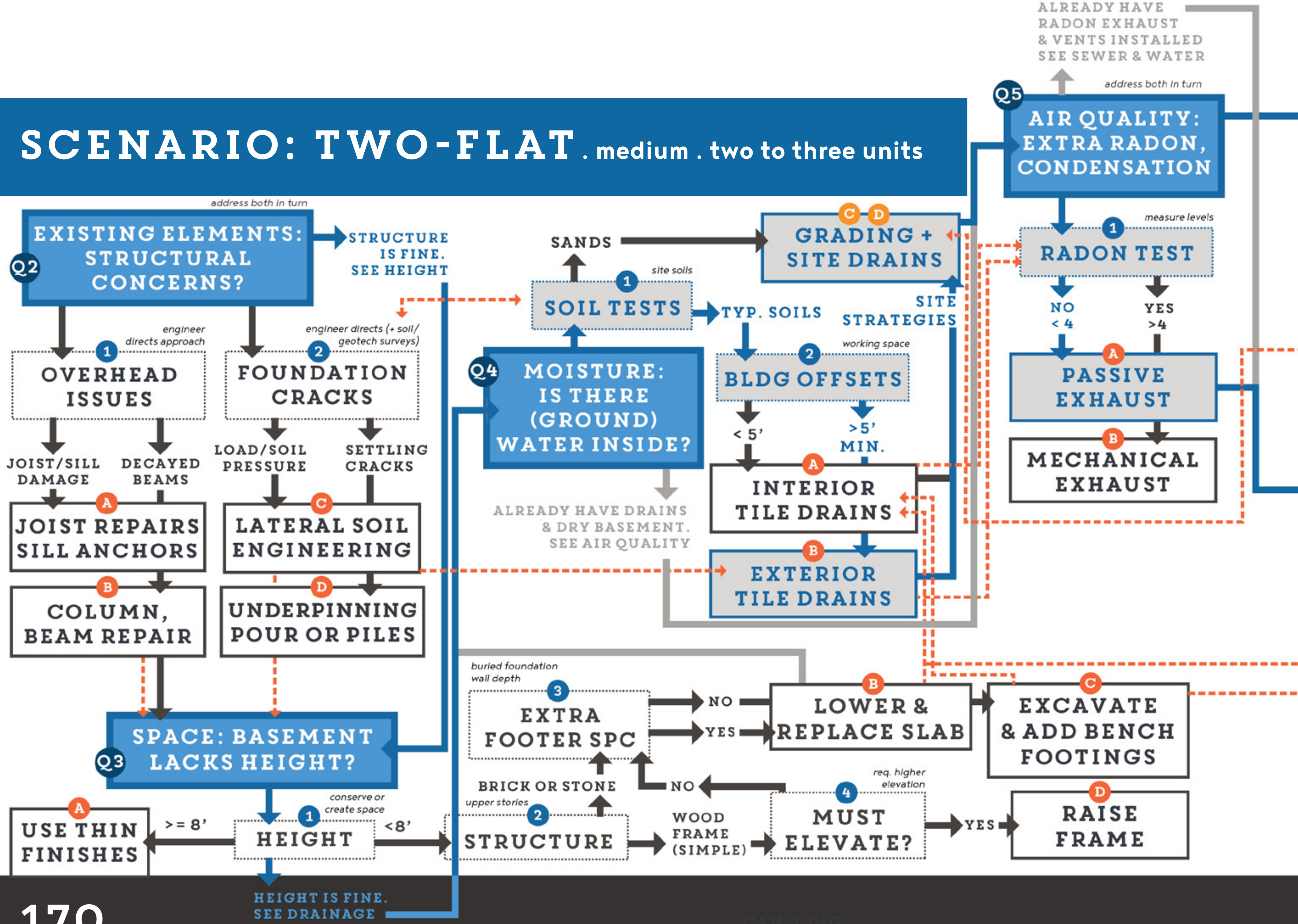
Estimate of Work: Two-Flat, Two-Bedroom Unit Conversion

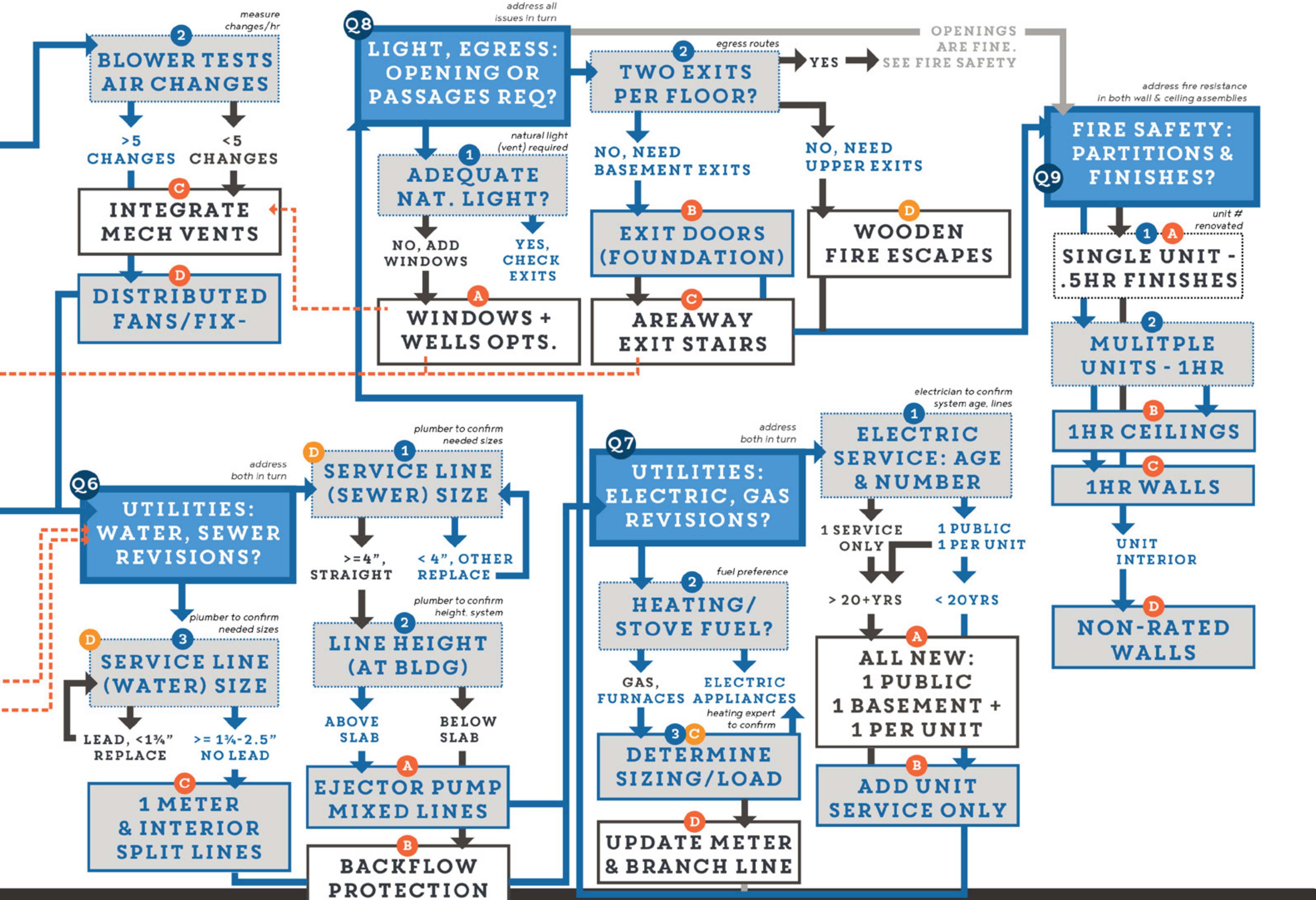
		low	mid	high
	City Permits	low	mid	high
Q1	Overall Building Permits	$ 4,000.00	$ 4,500.00	$ 6,750.00
	(permit specific fees)			
	Lead Clearance	$ 300.00	$ 400.00	$ 500.00
	General Demolition Costs			
Q4	Catch Basin demolition	$ 200.00	$ 475.00	$ 550.00
	Site - Drainage, Passages, General Work			
Q4	New surface sidewalks	$ 800.00	$ 1,720.00	$ 1,800.00
	Area drains around site	$ 1,280.00	$ 1,600.00	$ 2,300.00
	Window Replacement			
	none required			
	Doors & Exits			
	none required			
	Interior, main structure			
	Structure & Loading			
	none required			
	Slab, Waterpoofing & Vapor Barriers			
Q3	Slab repair (patches)	$ 2,000.00	$ 2,500.00	$ 2,800.00
Q3 TO Q5	***Barriers & Drainage/Sump System***			
	Air seal envelope (w/ slab patching)	$ 2,700.00	$ 6,000.00	$ 7,150.00
	Sump pump and tiles (full perimeter syste	$ 5,950.00	$ 8,900.00	$ 10,200.00
	Utility connections & lines			
	Gas			
Q7	New gas line interior piping	$ 700.00	$ 980.00	$ 1,800.00
	Water			
Q6	Interior water pipes	$ 3,500.00	$ 4,800.00	$ 5,250.00

		low	mid	high
	Sewage and Ejector Pump			
Q6	Interior horizontal lines for waste & ventir	$ 4,200.00	$ 4,500.00	$ 4,900.00
	Ejector pump added	$ 1,750.00	$ 2,100.00	$ 7,050.00
	Electric			
Q7	rewire new apartment	$ 4,950.00	$ 7,850.00	$ 8,300.00
	Ventilation & Plumbing Fixtures			
	Heating and Centralized Ventilation			
Q5	Furnace and ducts (basement)	$ 1,200.00	$ 1,600.00	$ 4,600.00
	Radon Exhaust - active (retrofit to new pip	$ 500.00	$ 1,500.00	$ 2,500.00
	Revised Laundry Facilities			
	none required			
	Kitchen (default fixtures)			
	Kitchen sink	$ 250.00	$ 300.00	$ 380.00
	light over sink	$ 120.00	$ 180.00	$ 350.00
Q5	range hood	$ 345.00	$ 375.00	$ 550.00
	Bath (default fixtures)			
	plumbing fixtures	$ 1,195.00	$ 1,700.00	$ 2,300.00
	lav light	$ 120.00	$ 180.00	$ 350.00
Q5	exhaust fan	$ 325.00	$ 400.00	$ 650.00
	Egress & Unit Access (see also exterior)			
	none required			
	Interior finishes & Fire Partitions			
	Ceilings			
	paint ceiling	$ 700.00	$ 975.00	$ 1,100.00
	Walls			
	partition walls - wooden studs	$ 6,300.00	$ 6,400.00	$ 11,500.00
Q9	drywall 1/2" (interior)	$ 6,500.00	$ 8,080.00	$ 13,500.00
	drywall 5/8" (1hr fire partition)	$ 3,500.00	$ 4,250.00	$ 5,200.00
	Finishing costs by rooms			

	low	medium	high
see 'Building Equity' for room by room estimate			
Project Sums	$ 71,590.00	$ 96,135.00	$ 136,770.00

SCENARIO: TWO-FLAT . medium . two to three units




measure changes/hr
2
BLOWER TESTS AIR CHANGES
>5 CHANGES
<5 CHANGES
C
INTEGRATE MECH VENTS
D
DISTRIBUTED FANS/FIX-
Q8
address all issues in turn
LIGHT, EGRESS: OPENING OR PASSAGES REQ?
natural light (vent) required
1
ADEQUATE NAT. LIGHT?
NO, ADD WINDOWS
YES, CHECK EXITS
A
WINDOWS + WELLS OPTS.
egress routes
2
TWO EXITS PER FLOOR?
YES
OPENINGS ARE FINE. SEE FIRE SAFETY
NO, NEED BASEMENT EXITS
NO, NEED UPPER EXITS
B
EXIT DOORS (FOUNDATION)
C
AREAWAY EXIT STAIRS
D
WOODEN FIRE ESCAPES
address fire resistance in both wall & ceiling assemblies
Q9
FIRE SAFETY: PARTITIONS & FINISHES?
unit # renovated
1 A
SINGLE UNIT - .5HR FINISHES
2
MULITPLE UNITS - 1HR
B
1HR CEILINGS
C
1HR WALLS
UNIT INTERIOR
D
NON-RATED WALLS
Q6
address both in turn
UTILITIES: WATER, SEWER REVISIONS?
plumber to confirm needed sizes
D 3
SERVICE LINE (WATER) SIZE
LEAD, <1¾" REPLACE
>= 1¾-2.5" NO LEAD
C
1 METER & INTERIOR SPLIT LINES
plumber to confirm needed sizes
D 1
SERVICE LINE (SEWER) SIZE
>=4", STRAIGHT
< 4", OTHER REPLACE
plumber to confirm height, system
2
LINE HEIGHT (AT BLDG)
ABOVE SLAB
BELOW SLAB
A
EJECTOR PUMP MIXED LINES
B
BACKFLOW PROTECTION
Q7
address both in turn
UTILITIES: ELECTRIC, GAS REVISIONS?
fuel preference
2
HEATING/ STOVE FUEL?
GAS, FURNACES
ELECTRIC APPLIANCES
heating expert to confirm
3 C
DETERMINE SIZING/LOAD
D
UPDATE METER & BRANCH LINE
electrician to confirm system age, lines
1
ELECTRIC SERVICE: AGE & NUMBER
1 SERVICE ONLY
1 PUBLIC 1 PER UNIT
> 20+YRS
< 20YRS
A
ALL NEW: 1 PUBLIC 1 BASEMENT + 1 PER UNIT
B
ADD UNIT SERVICE ONLY