Tabor East Apartments

7298 SE Division St.

Project Summary

Project Type:	Multi-family residential retrofit - demonstration project
Technologies:	Landscape infiltration swales; landscape infiltration basins; downspout disconnections to splash blocks
Major Benefits:	• All of the storm drains will be completely disconnected from the combined sewer system; runoff from more than 61,800 sq. ft. of impervious surface will infiltrate on-site. • The stormwater facilities will remove more than 1,386,792 gallons of runoff from the sewer in a typical rain year, with corresponding reductions in runoff pollutants. • Over 13,000 sq. ft. of landscaping will be added, improving the urban environment and the aesthetic appeal of the property.
Cost:	Expected total budget: $240,707 (the project has not been completed). The total cost includes some components that were not essential to the stormwater management goals. BES provided a $30,000 grant for the project.
Constructed:	Phase I: summer 2002. Phase II: fall 2004.

Overview of the Stormwater System

- The apartment complex is divided into 6 sub-catchments (see Figure 1).
- Most of the sub-catchments drain to a system of linked swales and basins along the edges of the buildings and parking lots.
- The new system receives runoff from over 26,000 sq. ft. of parking lot and 35,800 sq. ft. of roofs.
- Approximately 7,200 sq. ft. of asphalt was removed to create landscape stormwater facilities. Portions of the existing parking lots were re-graded to direct runoff into the stormwater facilities.
- The second and final phase will be completed in fall 2004.

Aerial view of the property prior to the project. Division Street is at the top (north) end of the photo.

Division Street Entrance

System Components and Stormwater Capacity

Stormwater Management Goal

The goal was to meet the standard for total on-site disposal of runoff: the facilities were designed to retain at least 3 in. of rainfall in a 24-hour period.

A typical section of the complex prior to the project - subcatchment #2 looking east.

Geotechnical Evaluation/Infiltration Test

The Natural Resources Conservation Service (NRCS) soil survey for Multnomah County classifies the soils as 52A, Urban Land – Multnomah complex. Much of the land in this category has been developed or otherwise disturbed. The estimated range for infiltration is 0.6–2.0 in. per hour.

A 1989 summary of existing geological studies from surrounding nearby areas included bore logs from SE 66th and Mt. Tabor Park (Sweet-Edwards/EMCON). The bore logs reported "clay and gravel" from 2-10 ft. below grade, underlain by "loose gravel and sand". A log recorded at SE 76th and Mill reported "brown sand" from 4-191 ft. below grade.

At the request of the City's Bureau of Development Services (BDS), the property owner conducted informal infiltration tests to confirm the adequacy of near-surface infiltration rates. Eight 5-gallon buckets (bottoms removed) were buried 1 ft. below grade. The buckets were filled with 1 ft. of water and the infiltration rate was documented over time. Most of the water in the buckets infiltrated within 6 hours; the average infiltration rate was approximately 2 in. per hour. BDS approved the project based on the results of the informal test, the existing geological data, and knowledge about nearby infiltration projects.

System Components

Swales

The swales convey runoff to the landscape infiltration basins, but they also provide infiltration. They are typically 6 in. deep; they were excavated to a depth of approximately 2 ft. (mid-point), and backfilled with 18 in. of topsoil and then a layer of river rock. Some of them were excavated to a depth of 3 ft. and backfilled with a foot of gravel before backfilling with topsoil and a layer of river rock. The swales do not have check dams.

Landscape Infiltration Basins

The basins receive runoff from one or more of the swales. Their specifications are similar to those for the swales with the exception of their width (they range in width from 8 to 20 ft.).

Rock-filled Infiltration Basins

The basins provide additional capacity within some of the landscape infiltration basins along Division Street. There are four of them; all of them are covered by decks. They are each 6 ft. wide, 6 ft. long, and 4 ft. deep. There is 2.5 ft. of river rock in the bottom, covered by a foot of ¾ in. minus crushed rock. A half foot of topsoil sits on top of the crushed rock. No filter fabric was used in the construction of the basins, but the sides adjacent to the buildings are lined with impermeable fabric to protect the foundations.

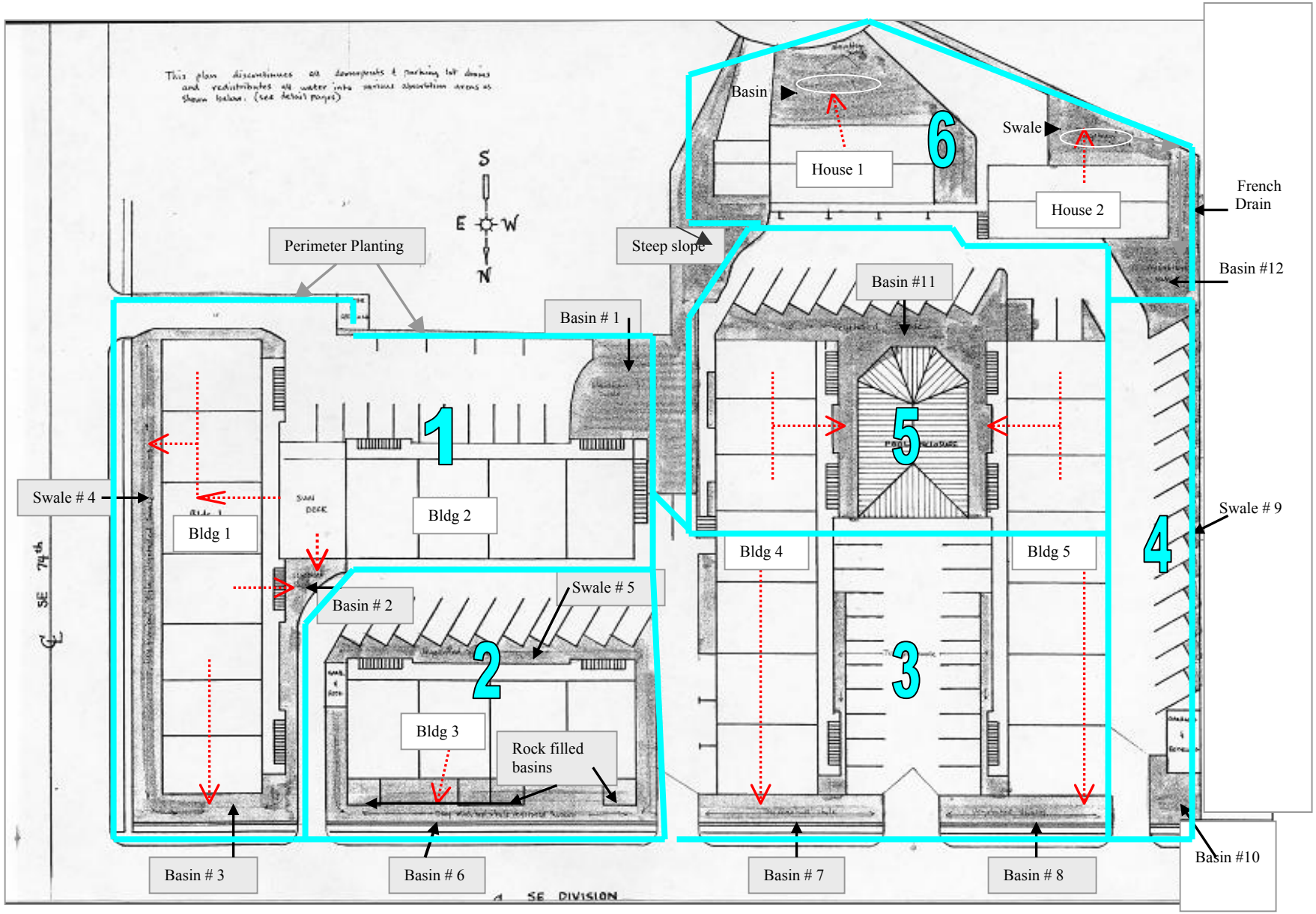

Figure 1. Plan of the apartment complex with the locations of the stormwater management facilities. The red arrows indicate the direction of travel for runoff from the roofs.

Landscape Areas
Subcatchment Outline
Overall flow direction (roof runoff)

System Components (Continued)

Conveyance Systems
The systems include splash blocks, sub-surface pipes, and asphalt berms.

A typical swale just after construction - subcatchment #2 looking west.

DEQ requires simple registration of all subsurface stormwater disposal systems. See the following web-site for current information: http://www.deq.state.or.us/wq/groundwa/uichome.htm

Sub-catchment # 1
(See Site Plans for drainage details, pg. 3 & 12)
Catchment Area: 12,540 sq. ft. of roof ; 5,348 sq. ft. of asphalt
Total Facility footprint: 5,740 sq. ft.
Internal Volume: 4,570 cu. ft. (reported by owner)
Facility Components:

- **Basin # 1** *(1,820 sq. ft.)*
  - Receives runoff from the adjacent parking lot (*4,250 sq. ft.)*.
  - Portions of the parking lot were re-graded to direct runoff into the basin.
  - Overflow from the basin enters a subsurface pipe that discharges to **Swale # 4.**
- **Basin # 2** *(280 sq. ft.)*
  - Receives roof runoff from portions of Buildings 1 and 2 *(2,112 sq. ft. total).*
  - Overflow is conveyed along the west side of Building 1 to **Basin #3** (along Division St.).
- **Basin #3**
  - Receives runoff from a portion of Building 1 *(2,288 sq. ft),* overflow from **Basin #2** and **Swale #4,** and part of an adjacent driveway *(350 sq. ft).*
  - Serves as the terminus for the linked facilities in sub-catchment #1.
- **Swale # 4** (3,060 sq. ft)
  - Receives runoff from: part of a driveway at the SE corner of the property (*748 sq. ft);* Buildings 1 and 2 via disconnected downspouts *(8140 sq. ft.);* and overflow from **Basin #1 -** a subsurface pipe was cored through the foundation slab of apartment Building 1.
  - The swale was excavated as deep as 3 feet prior to backfilling with topsoil .

Sub-catchment #2
(See Site Plans for drainage details, pg. 3 & 12)
Catchment Area: 5,400 sq. ft. of roof
7,060 sq. ft. of asphalt
Total Facility footprint: 3,032 sq. ft. total
Internal Volume: 2,786 cu. ft. (reported by owner).
Facilities:

- **Swale # 5** (*2,272 sq. ft.)*
  - Receives runoff from the adjacent parking lot *(5,980 sq. ft.)* and part of Bldg. 3 *(2,240 sq. ft.)*.
  - The north edge of the parking lot was saw-cut in a zigzag pattern; all of the parking spaces were preserved and reconfigured along a diagonal.
  - Portions of the parking lot were re-graded to direct runoff into the swale.
  - Overflow drains to **Basin # 6** on the building's north side.

Basin # 6 *(760 sq. ft.)*

- The basin receives overflow from **Swale #5,** runoff from the north side of building 3 *(3,164 sq. ft.),* and runoff from adjacent asphalt *(1,080 sq. ft.).*
- Four rock-filled infiltration basins provide extra capacity.
- The basin serves as the terminus for the linked facilities in the sub-catchment.

Landscape infiltration basin in the upper parking lot - subcatchment 1, basin 1; 2004

Sub-catchment #3 (Phase II - to be constructed in 2004)
(See Site Plans for drainage details, pg. 3 & 12)
Catchment Area: 9,416 sq. ft. of roof
7,280 sq. ft. of asphalt
Total Facility footprint: 1,448 sq. ft.
Internal Volume: 1,342 cu. ft. (reported by owner).
Facilities:

- **Basin # 7** *(744 sq. ft.)*
  - The basin receives runoff from two adjacent parking lots *(3,640 sq. ft.)* and roof runoff from almost two-thirds of Building 4 *(4,708 sq. ft.).*
  - Parts of the asphalt will be re-contoured to direct stormwater into the basin.
- **Basin # 8** *(704 sq. ft.)*
  - The basin will receive runoff from half of the parking lot between Buildings 4 and 5 *(3,640 sq. ft.).*
  - The basin will receive roof runoff from almost two-thirds of building 5 *(3,640 sq. ft.).*
  - The parking lot will be re-contoured to direct stormwater toward the basin.

Landscape infiltration basin with disconnected downspout - subcatchment 1, basin 2; 2004

Sub-catchment # 4
(See Site Plans for drainage details, pg. 3 & 12)
Catchment Area: 6,326 sq. ft. of asphalt
Total Facility footprint: 1,015 sq. ft.
Internal Volume: 1,565 cu. ft.
Facilities:

- **Swale # 9** (*655 sq. ft.)*
  - Receives runoff from the adjacent parking area *(5,846 sq. ft.).*
  - The adjacent 7-ft. high retaining wall is protected from hydrostatic pressure by weep holes.
  - The west edge of parking lot was saw-cut in a zigzag pattern; all of the parking spaces were preserved and reconfigured along a diagonal.
  - The entrance road adjacent to the spaces splits runoff to the north and the south. Portions of the road and parking lot were re-contoured to direct flow into the swale.
  - Overflow is drains to **Basin #12** (the terminus for sub-catchment 6).

- **Basin # 10** *(360 sq. ft.)*
  - The basin is in the NW corner of the property. An asphalt berm directs runoff from the parking lot into the basin *(480 sq. ft.).*

Sub-catchment #5 (Phase II to be constructed in 2004)
(See Site Plans for drainage details, pg. 3 & 12)
Catchment Area: 8,448 sq. ft. of roof
Total Facility footprint: 3,480 sq. ft.
Internal Volume: 2,610 cu. ft.
Facilities:

- **Basin # 11** (*3,480 sq. ft.)*
  - The basin will have three sections: a section adjacent to the parking area, and sections on either side of the pool enclosure.
  - The east side will receive approximately 1/3 of the roof runoff from Building 4; the west side will receive approximately 1/3 of the runoff from Building 5 *(8,448 sq. ft. total)*.
  - Part of the parking lot will be re-contoured to direct runoff into the basin.

Landscape infiltration basin along Division Street (deck covers rock-filled basin) - subcatchment 2, basin 6; 2004

Sub-catchment # 6
(See Site Plans for drainage details, pg. 11-12)
Catchment Area: 3,800 sq. ft. of roof; 300 sq. ft. of driveway
Total Facility footprint: 380 sq. ft.
Overall Internal Volume: 420 cu. ft.
Facilities:

- An infiltration basin south of House #1 receives roof runoff from the house *(1,900 sq. ft.)*.
- A swale south of House #2 receives roof runoff from the house *(1,900 sq. ft.)*. Overflow drains around the west side of the house to a French drain (2 x 2 x 25 cu. ft.), which drains to Basin #12. Basin #12 also receives runoff from the adjacent parking lot to its east and overflow from Basin #9.
- Over 1,800 sq. ft. of asphalt was removed to create the basin.

Recently planted swale - subcatchment 1, swale 4, looking south (note pipe outlet at south end); 2002

Landscaping

- The project added approximately 13,800 sq. ft. of landscape.
- The vegetation is a mix of native and non-native ornamental plants. Plantings included 3- 8 in. caliper trees (up to 20 ft. in height), middle story shrubs, low-growing groundcover, and a variety of grasses.
- The plantings include plants recommended in the SWMM, but also includes non-native species such as Heather, Zebra Grass, Honeysuckle, and Japanese Holly.
- A cover mulch of 4-8 in. diameter river rock controls erosion and provides aesthetic interest.
- The project triggered 2 different landscaping requirements from City code Title 33: requirements for multi-family residential landscaping (L-1 general landscaping) and requirements for landscaping around the perimeter of parking lots.
- Although the project did not trigger the requirements of the SWMM, all of the facilities conform with its specifications and in most cases provide more capacity than recommended.

Irrigation
The project included over 700 lineal ft. of drip irrigation hose. It was installed just below the soil surface, delivering water directly to the roots.

Emergency Overflow Path

- The keystone wall along Division Street borders the terminal stormwater facilities for much of the site.
- The blocks are cemented together to prevent injury and vandalism. Stormwater can seep through small openings in the wall; in very large storms, runoff may cross the sidewalk to the public right-of-way.

Budget

The estimated final budget is $240,707, including design of phases I and II, management, and construction. Phase I was completed in 2002 at a cost of $203,252; the estimated cost of Phase II, to be completed in 2004, is $37,455 (based on actual costs from Phase 1). The property owner designed the project; the budget includes his hours at an hourly rate of $131.00. BES contributed $30,000 in grant funds to the project.

Table 1.

Tabor East Apt. Budget Summary			
Item	**Item Cost Phase l**	**Est. Item Cost Phase ll**	**Total Cost Phase I & II**
Design & Project /Construction Management	$ 69,500.00		**$ 69,500.00**
Demolition, excavation, grading			**$ 26,700.00**
Concrete/asphalt cutting	$ 750.00	$ 400.00	
Concrete and asphalt export (7,200 sq. ft.)	$ 2,100.00	$ 1,600.00	
Excavation & grading - basins, swales	$ 19,350.00	$ 2,500.00	
Subtotal	***$ 22,200.00***	***$ 4,500.00***	
Construction:			**$ 62,634.00**
Piping - Plumbing and downspout rerouting	$ 7,091.00	$ 1,575.00	
Retaining walls	$ 9,085.00	$ 1,500.00	
Decking over collection basin??	$ 21,532.00	———	
Asphalt repaving	$ 13,901.00	$ 7,950.00	
Subtotal	***$ 51,609.00***	***$ 11,025.00***	
Landscaping (13,817 sq. ft.)- material and labor			**$ 80,128.00**
Trees and shrubs	$ 21,745.00	$ 7,300.00	
Other plants	$ 22,533.00	$ 10,580.00	
Relocate plants / Tree removal	$ 7,600.00	$ 1,000.00	
River rock and liner	$ 5,245.00	$ 2,500.00	
Drip irrigation	$ 1,075.00	$ 550.00	
Subtotal	***$ 58,198.00***	***$ 21,930.00***	
Miscellaneous:			
Permit (Phase I & II)	$ 1,745.00		**$ 1,745.00**
TOTAL	**$ 203,252.00**	**$ 37,455.00**	**$ 240,707.00**

* River rock was used as both a cover mulch for the facilities and structurally in the infiltration basins.

I. Budget Elements (estimates)

Non-Construction Activities
The total estimated cost for management, design, and permitting is $71,245 or approximately 30% of the total budget.

- **Management (Project and Construction Management) & Design**
  The property owner, a licensed contractor, spent approximately 475 hours managing and designing the project. Prior to undertaking the project himself, he received four bids for the project from licensed landscape architects. Based on the average hourly rates from those bids, he valued his time at $ 131 per hour. At that rate, the estimated total cost for management and design was $69,500 or 29% of the total budget.

- **Permits**
  The site permit for phase I and II was $1,745 or almost 1% of the total budget. Labor costs to coordinate the original permit submittal, as well as the appeal process, are included in the management and design costs described above.

Construction Activities
Demolition, excavation, construction, and landscaping costs totaled $169,462 or 70% of the total budget.

- **Demolition, Excavation, and Grading**
  Site preparation activities, including removal of the existing asphalt (approximately 7,200 sq. ft.), concrete cutting, and excavation for the swales and basins, cost $26,700 or about 11% of the total budget. The unit cost for removing and exporting the asphalt and concrete was $1.48 per sq. ft.

- **Construction**
  The core construction activities, including modification of the downspouts, installation of collection pipes, asphalt re-surfacing, and construction of the retaining walls and decking, cost approximately $62,634 or 26% of the total budget.

- **Landscaping**
  The project include over 13,000 sq. ft. of new landscaping at a cost of $80,128 or about 33% of the total budget. Landscaping costs include materials and labor, relocating existing plants, and a drip irrigation system.

II. Cost Components

Landscaping
Landscaping costs contributed substantially to the budget. The unit cost of purchasing and installing the vegetation was approximately $5.00 per sq. ft., which is at the high end of the range for similar projects. The owner's goal was to achieve immediate visual and functional benefits. The biggest added cost was due to the trees, which were larger and more mature than required by city code. The extensive use of river rock also raised landscaping costs.

Decking
Fenced decks were constructed over each of the rock-filled infiltration basins (in front of buildings # 3). Although the decks are functional features, they are not essential elements for the stormwater project. The total cost for the decking and fencing was $21,532, comprising 8% of the total budget.

Newly planted swale showing downspout disconnections (splash blocks); 2002

Construction Contractor
The owner hired three contractors for the work. One contractor completed the paving work; a second contractor, a licensed plumber, carried out the piping and downspout disconnection activities. The third contractor performed all the remaining work - excavation, concrete and asphalt cutting, hauling, planting, placing ground cover and river rock, waterproofing, and other miscellaneous tasks. The owner believes he substantially reduced the cost of construction by having one contractor handle the majority of work.

Close-up showing new layer of asphalt applied to regrade parking lot; 2004

Plumbing
Plumbing costs were relatively low: just 300 linear ft. of pipe was installed at a total cost of $7,100. Most of the downspouts were disconnected to splash blocks, and the majority of the conveyance systems are swales rather than pipes. There are no piped overflows ("emergency overflows") in the system; the designer used the existing grades to create linked systems with capacity for on-site disposal (infiltration). The only overflow path to the public right-of-way is through the retaining walls along Division Street.

Asphalt work
The owner realized substantial cost savings by re-grading the parking lot surfaces rather than replacing the asphalt to direct drainage to the new landscape areas. He simply overlaid portions of the existing parking lot surface with varying thicknesses of new asphalt.

Design
Had the owner hired a professional landscape architect to design the project, his own effort would have been significantly reduced. But he would have incurred substantial additional costs. The high bids for the design work were the main reason the owner opted to do that work himself.

III. Cost Comparisons

The property owner incurred higher costs than typical for the plantings, and he included a relatively expensive feature, decking along Division Street, that was not central to the stormwater management goals. He saved on costs by minimizing the length of conveyance pipe and asphalt re-surfacing required for the project; other projects of similar scope might incur higher costs for this type of work. According to the owner he also saved substantially by hiring a single company to do almost all of the construction work.

It is particularly difficult to determine the comparative value of the owner's design work. Although the estimated design costs (in the original bids) led him to design the project himself, he may have spent a greater amount of time than a professional would have. The budget factors the owner's time at $131 per hour, a number based on the bids the owner received before deciding to design and manage the project himself.

Maintenance and Monitoring

The owner of the property is responsible for all maintenance activities.

BES will monitor the performance of the facilities at Tabor East Apartments for at least five years, and perhaps longer. Confirming the hydraulic performance of the facility will be a primary focus. BES will also regularly evaluate the level of effort required to maintain the facility, the success of the planting regime, and comments from the owner.

Successes and Lessons Learned

Design – The design is ingenious in how it incorporates a network of infiltration facilities into an existing, densely developed apartment complex. The project demonstrates how stormwater management systems can be integrated into the design of an existing property, providing attractive landscape features and improving the appearance of the property.

Professional Services Vs. Do-It-Yourself - The owner, a licensed contractor, proved very capable at designing the project and resolving permitting issues. His personal dedication to the success of the project led to innovative design approaches that may not have been undertaken had he contracted with professionals for the same services.

Motivation – The property owner had intended to add substantial landscaping to the property prior to receiving information about the stormwater grant program. Coupled with his interest in potential savings on his stormwater bill, the project is a great example of a property owner who recognized multiple benefits in the retrofit project.

Design Review – The stormwater project was part of a larger group of improvements to the property project with many associated permitting issues. A "pre-application meeting" with the City's Bureau of Development Services was essential to clarify the many permitting issues.

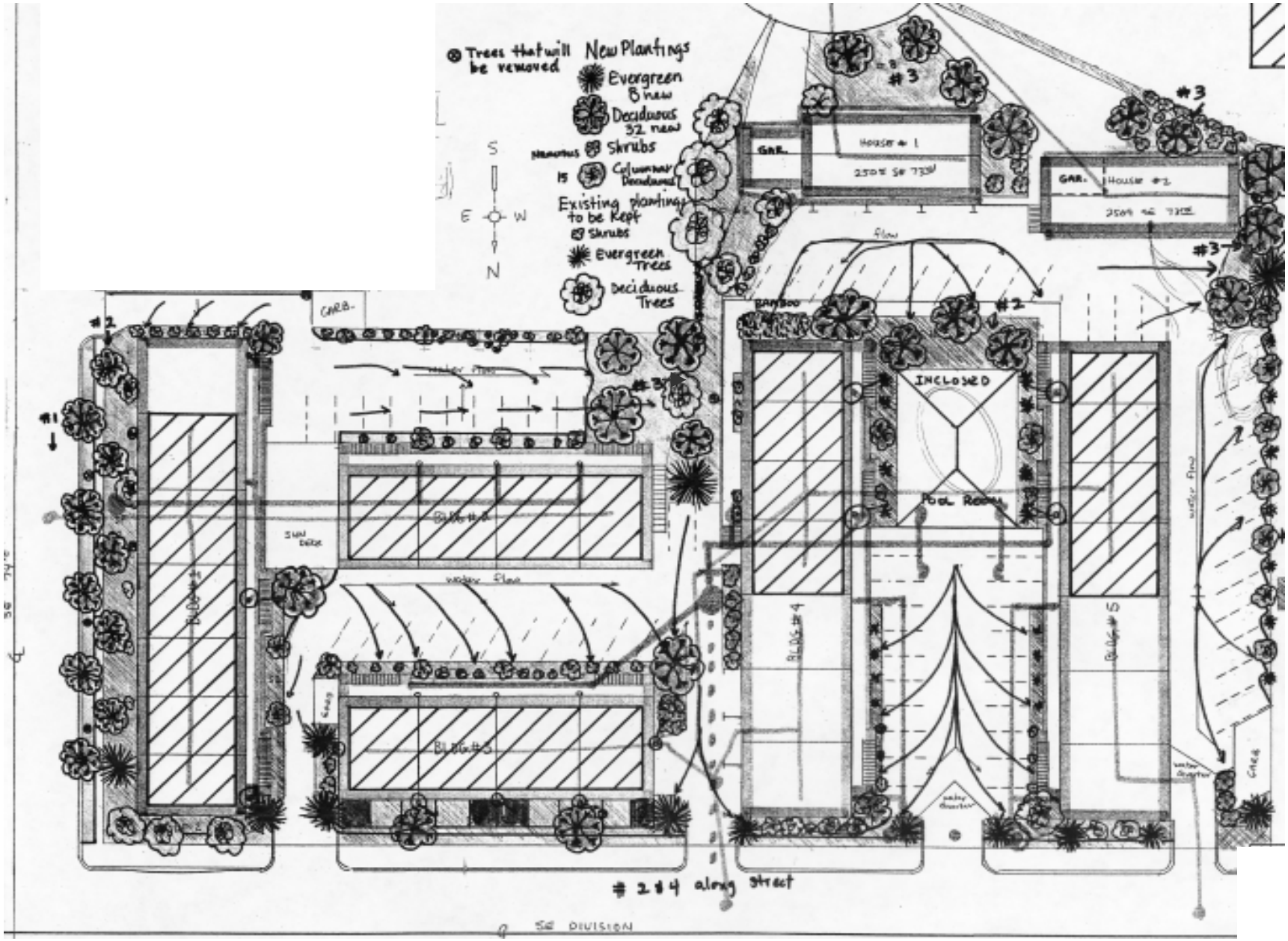

Figure 2. Site Plan of Tabor East Apartment complex indicating flow patterns of parking lots.