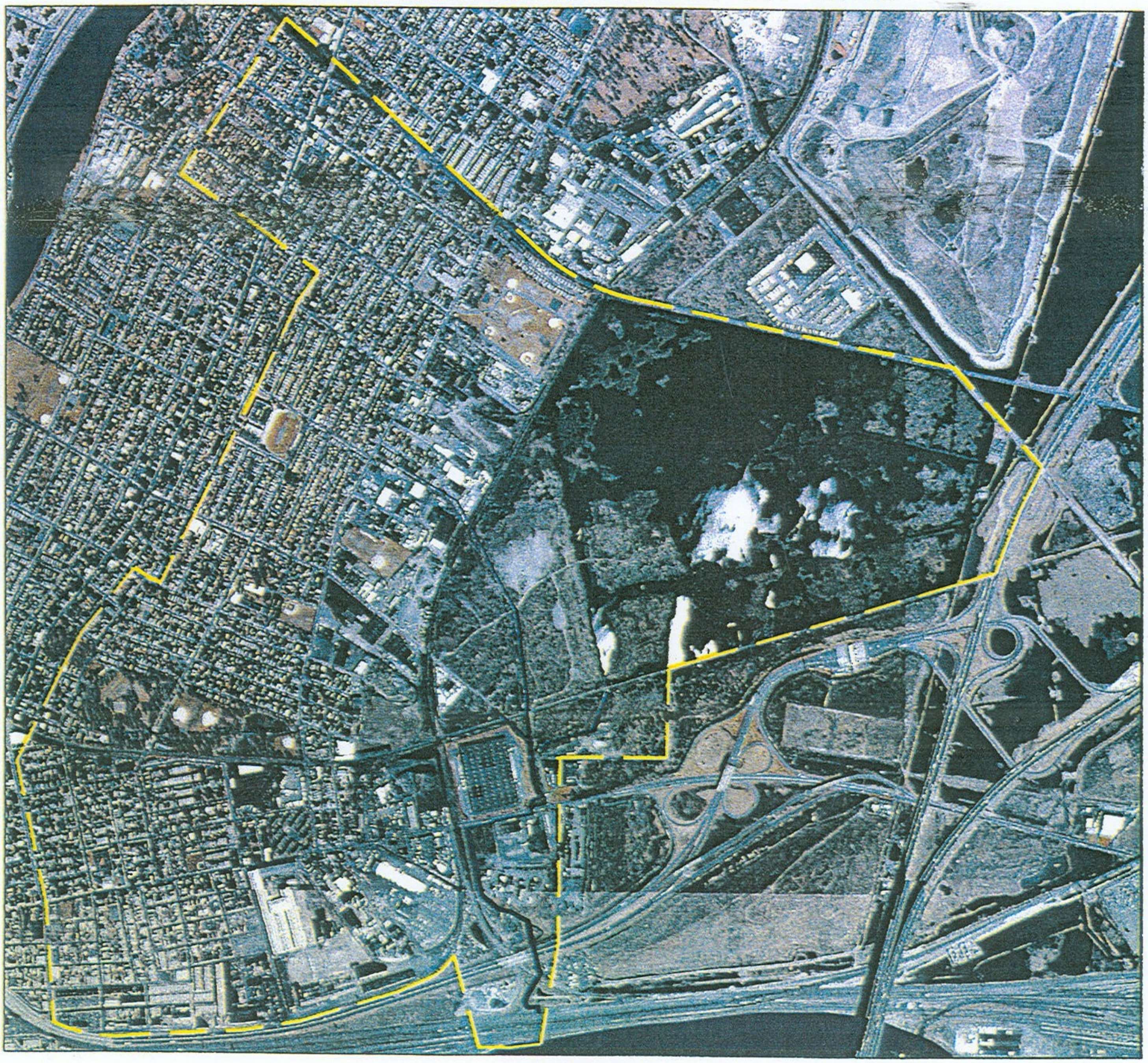
STORM WATER EVALUATION
DRAINAGE STUDY
PREPARED FOR
THE TOWN OF KEARNY
HUDSON COUNTY, NEW JERSEY
JANUARY 2001

NEGLIA ENGINEERING PROJECT NO. 10129



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JOSEPH E. NEGLIA, P.E., P.L.S., P.P. — *PRESIDENT*
MICHAEL J. NEGLIA, P.E., P.L.S. — *VICE PRESIDENT*
DOMINICK VILLANO, P.E.
JOANN SIGNA

February 14, 2001

Mayor and Council
Town of Kearny
402 Kearny Avenue
Kearny, NJ 07032

Re: Drainage Study and Analysis
East of Schuyler Avenue
Gunnell Oval to Dukes Street
Our file: 10129 – K. Pending

Honorable Mayor and Council:

In accordance with direction from the Mayor and Council of the Town of Kearny, and promulgated by a resident's meeting on September 23, 1999, Neglia Engineering Associates has undertaken, completed, and is hereby submitting a stormwater study of the area bounded by the Erie Lackwanna Railroad Co., NY and Greenwood Lake Branch, Schuyler Avenue and the New Jersey Turnpike.

We have attempted to take into account, within the scope of the study, the various and numerous factors which directly or indirectly would have an influence upon the recommended improvements to the systems of storm drains and open swales that presently exist within the areas as described above.

This office would like to express our gratitude and acknowledge the fine cooperation received from the Mayor and Council; the Kearny Department of Public Works, Cali Safe Environmental, and the Hackensack Meadowlands Development Commission for their cooperation and the assistance rendered by them in the preparation of this report.

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I trust you will find the above in order. Should you have any questions, please do not hesitate to contact the undersigned.

Very truly yours,
Neglia Engineering Associates

Joseph E. Neglia, P.E., P.L.S., P.P.
Town Engineer
Town of Kearny

JEN/dv/st

Attachment

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KEARNY DRAINAGE REPORT

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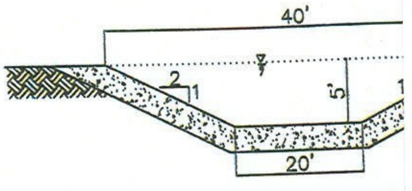
I. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Upon our analysis of the existing drainage system, it was determined that all mini-systems within the study area are in need of upgrading in order to offer some relief from the reoccuring flooding problems.

We must emphasize that the proposed improvements are designed to provide substantial relief from a storm frequency from one in twenty- five years (otherwise referred to as the twenty-five storm frequency event). However, should the Town of Kearny experience a higher frequency storm, coupled with high tides, these areas will continue to flood along with various other sections of the Town.

Sections VII and VIII of this report, entitled "Recommended Improvements" and "Estimated Project Costs", respectively describe our findings for each mini-system. These sections provide several recommended improvements along with associated construction costs.

The overall cost of these improvements is estimated at approximately Fifty Million Dollars ($50,000,000.00). In developing these costs, we assume that the dredge material may contain low levels of contaminations that can be limited by utilizing existing area landfills as disposal sites. Should analytical test results detect stronger levels of contaminants, the cleanup costs could well exceed the costs of these drainage improvements. We realize that the overall improvements are substantial; therefore, the Town of Kearny should consider phasing the improvements based on priority and share the costs with the Hackensack Meadowlands Development Commission (HMDC) and Hudson County. The following section will show a phasing plan depicted on **Figure 6A** entitled **"Recommended Phasing Map"** along with the associated construction costs for each of the respective phases:



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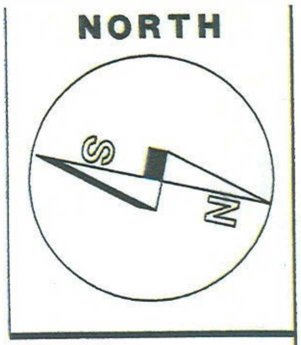

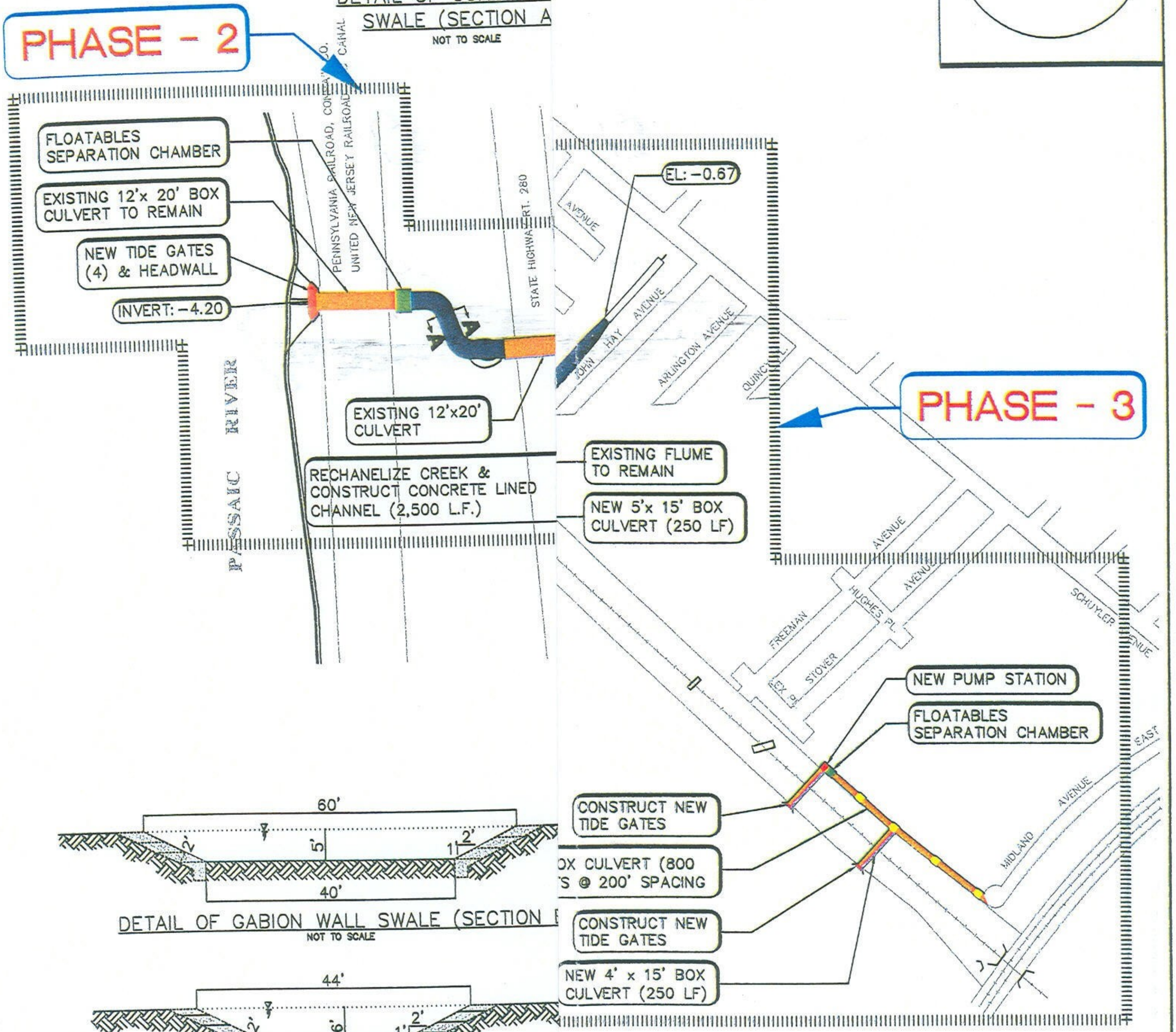
PHASE - 2
PENNSYLVANIA RAILROAD, CONRAIL CO.
UNITED NEW JERSEY RAILROAD & CANAL
STATE HIGHWAY RT. 280
FLOATABLES SEPARATION CHAMBER
EXISTING 12'x 20' BOX CULVERT TO REMAIN
NEW TIDE GATES (4) & HEADWALL
INVERT: -4.20
A
A
PASSAIC RIVER
EXISTING 12'x20' CULVERT
RECHANELIZE CREEK & CONSTRUCT CONCRETE LINED CHANNEL (2,500 L.F.)
EL: -0.67
AVENUE
JOHN HAY AVENUE
ARLINGTON AVENUE
QUINCY PL.
PHASE - 3
EXISTING FLUME TO REMAIN
NEW 5'x 15' BOX CULVERT (250 LF)
AVENUE
FREEMAN AVENUE
HUGHES PL.
STOVER PL.
SCHUYLER AVENUE
NEW PUMP STATION
FLOATABLES SEPARATION CHAMBER
CONSTRUCT NEW TIDE GATES
OX CULVERT (800
'S @ 200' SPACING
CONSTRUCT NEW TIDE GATES
NEW 4' x 15' BOX CULVERT (250 LF)
MIDLAND AVENUE
EAST
60'
2'
5'
1
2'
40'
44'
2'
6'
1'
2'
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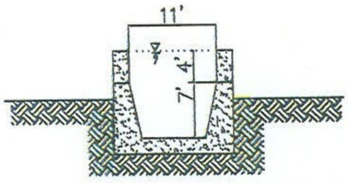

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GURE 6A
OMMENDED
SING MAP
N OF KEARNY
TY NEW JERSEY

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Phase I – Bergen Avenue Extension from Dead Horse Creek to Harrison Avenue

This work consists of completing the improvements under the phase IIB and IIC Sewer Separation Program, rechannelizing Dead Horse Creek and constructing Gabion Sidewalls, replacing the existing box culvert under the Erie Lackawanna Railroad Co., Newark and Hudson Branch with a new 4' high X 20' wide box culvert, rechannelizing that portion of Frank's Creek from Dead Horse Creek to Harrison Avenue and constructing a concrete lined channel, constructing a new 6' high X 15' wide box culvert under Harrison Avenue that will parallel the existing 5' high X 10' wide culvert, and constructing a new pump station in the area where the Dead Horse Creek converges with Frank's Creek. This phase will provide immediate relief to the area by alleviating the flooding which occurs in the Wilcata Box area and will provide the additional capacity that will be required due to the increase in runoff generated by the Phase IA, IIB and IIC Storm & Sanitary Sewer Separation Program.

The total cost of Phase I improvements is estimated at $18,600,00.00.

Phase II – Harrison Avenue to the Passaic River Tidegates

These improvements consist of rechannelizing Frank's Creek from Harrison Avenue to the existing tidegates adjacent to the Passaic River and constructing a concrete lined channel, replacing the existing tidegates and headwall structure by relocating same along the Passaic River in the area south of the Pennsylvania Railroad, Conrail Co. and United New Jersey and Railroad and Canal tracks. These improvements will provide additional conveyance capacity to Frank's Creek that will be required to service the entire study area.

The total cost of Phase II improvements is estimated at $10,920,000.00.

Phase III – Reopen drainage to Kearny Marsh and Redirect Frank's Creek

This phase includes draining the Kearny Marsh by constructing control structures along the Erie Lackawanna Railroad, Newark and Hudson Branch, channelizing a new drainage swale lined with Gabion Sidewalls from these outlet points to the Bergen Avenue extension, rechannelizing

Frank's Creek from Dead Horse Creek to the John Hay Avenue flume, installing new 5' high X 15' wide box culverts at the railroad crossings, constructing a new pump station and collection system at Gunnel Oval, redirecting Frank's Creek into the Kearny Marsh by channelizing a new drainage swale across the Keegan's Landfill, and reestablishing all the drainage swales that existed within the Kearny Marsh prior to the dissolution of the Hudson County Mosquito Control Commission.

The total cost of Phase III improvements is estimated at $20,280.00.

Please note that the $20,280,000.00 cost includes $9,600,000.00 for improvements to the Gunnel Oval System. Should the Mayor and Council choose to address only the athletic field drains for the Gunnel Oval Facility, the cost for a pump station and underdrain system is estimated at approximately $3,000,000.00.

We further recommend that the Hackensack Meadowlands Development Commission (HMDC) institute a program whereby they oversee any new development that is being proposed in this area and each development would contribute funds that can be utilized in improving the Kearny Marsh System. These funds would be directed in establishing a regional detention facility in lieu of constructing individual facilities for each of the respective development.

II. INTRODUCTION

a. Authorization

The Kearny Storm Drainage Study was authorized by the Mayor and Council of the Town of Kearny by Resolution Number 1999 ® 363 adopted on October 26, 1999.

b. Purpose

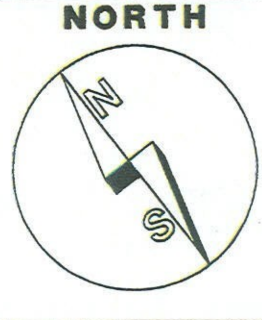
The purpose of this study was to evaluate the adequacy of the existing drainage system, within the scope of this study area, in light of the flooding problems experienced in the past and accentuated during peak rainfall events, mainly within the south easterly quadrant of the Town of Kearny.

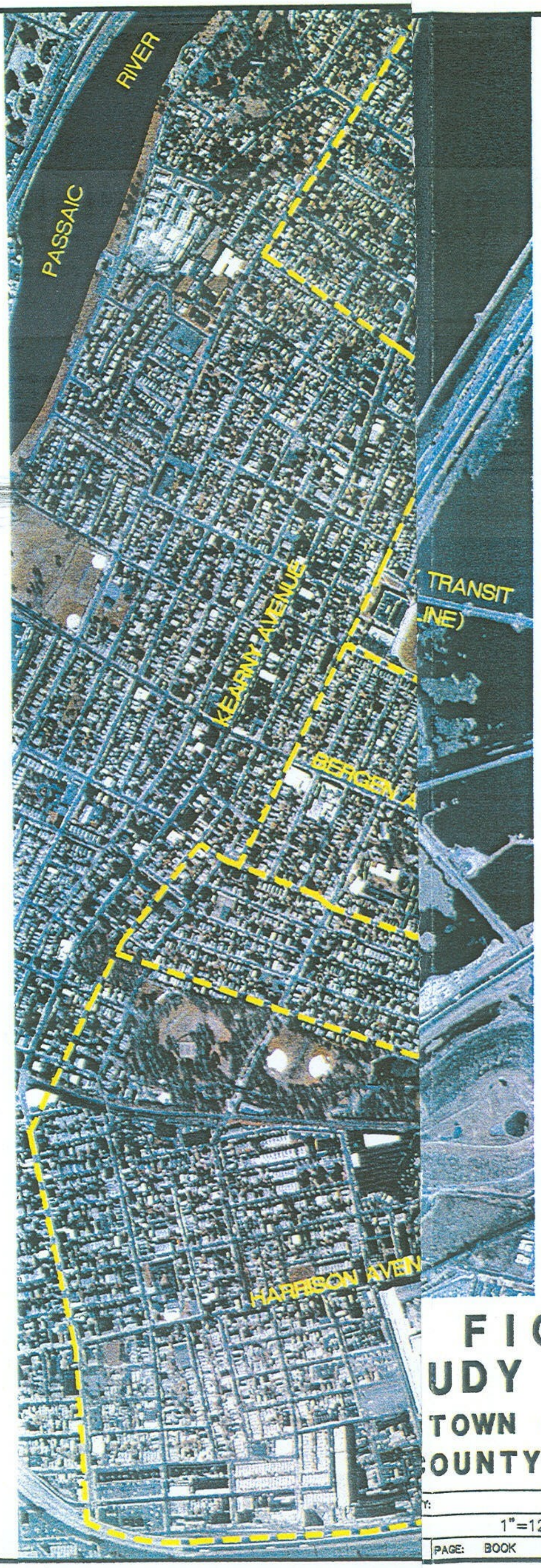
The data compiled in this study was analyzed to make recommendations to the Mayor and Council for remedial measures to alleviate the flooding problems that are being experienced.

The report is also intended to provide approximate costs for future construction that might be required to relieve the drainage system and allow for future development within this study area. However, it should be noted that all future development in this area should be in accordance with the stormwater management requirements as stipulated in the Residential Site Improvement Standards (RSIS).

c. Scope

The areas encompassed by this study are depicted on **Figure No. 1,** entitled "**Study Area Map.**" The study area consists of that portion of the Municipality bounded on the west by Schuyler Avenue, on the east by the New Jersey Turnpike, on the north by the Erie-Lackawanna Railroad Company-New York and Greenwood Lake Branch and on the south by the Passaic River and the Pennsylvania Railroad, Conrail Company, United New Jersey Railroad and Canal Company.




PASSAIC
RIVER
KEARNY AVENUE
TRANSIT
LINE)
BERGEN A
HARRISON AVEN

LEGEND

- - - - MINI-SYSTEM BOUNDARY LINE

—— EXISTING DRAINAGE SYSTEM

FIGURE 1
UDY AREA MAP

TOWN OF KEARNY
OUNTY NEW JERSEY

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The report was compiled from a combination of general field surveys, and existing plans and maps of the Town of Kearny. Pipe cleaning operations with high pressure water jets, dredging operations and interviews with local property owners and Town of Kearny personnel were also utilized and considered in this report.

III. GLOSSARY OF TERMS

In order that the reader might be familiar with the technical terms used in this report, the following Glossary of Terms is being offered to provide a convenient frame of reference.

1. **Catch Basins**
   The chamber utilized for the admission of surface water to an underground conduit. The catch basin differs from a storm water inlet in that the chamber is constructed with an invert depressed lower than the invert of the discharge pipe. That part of the structure below the discharge pipe is utilized for the detention and removal of solids, such as sand, grit, floatables and other debris that may be transported by street washings.

2. **Combined Sewer Overflow (CSO) Structure**
   A chamber with two outfalls utilized to direct wastewater to a treatment facility during dry weather conditions or into an open channel/stream during wet weather conditions.

3. **Combined System**
   A system of drainage by which sanitary sewage and surface water are carried in the same drains and/or sewer pipes.

4. **Design Storm**
   The precipitation estimate, in terms of rainfall, corresponding to a particular rainfall intensity-duration-frequency criteria developed from historical records. As utilized in this study, the design storm was considered to be of such magnitude as may be expected once in every twenty-five (25) years.

5. **Hydraulic Grade Line (HGL)**
   An imaginary curve along a flowing pipeline, which shows the levels to which the water could rise in open pipes leading up from it.

6. **Manhole**
   An access way, in the form of a vertical shaft or opening, to a storm drain or sanitary sewer for the purpose of inspection, maintenance and possible ventilation of the conduit.

7. **Outfall**
Point of discharge of storm water from a pipe or conduit to an open natural channel or watercourse.

8. **Precipitation**
The total measurable quantity of atmospheric moisture deposited on land or water surfaces in the form of rain, snow, hail or sleet.

9. **Sanitary Sewer**
A sewer pipe which is intended to carry sanitary waste.

10. **Storm Sewer**
A sewer pipe or drain which is intended to carry storm water.

11. **Storm Water**
The excess water running off from the surface of a drainage area during and immediately following a period of rain.

12. **Storm Water Inlet**
A chamber utilized for the admission of surface water to an underground conduit. The said chamber is constructed with flush inverts in order to enhance self-cleaning of the chamber.

13. **Surcharge**
A condition where a storm drain or sanitary sewer is subject to flow under pressure and is evidenced by the rise of the water/wastewater surface to heights above the crown of the pipe itself.

14. **Swale or Ditch**
A long narrow channel dug into the earth, as a trough for drainage.

15. **Watershed or Drainage Basin**
The gross land area draining to a particular point by natural overland flow or through man-made hydraulic structures.

IV. GENERAL FEATURES

The upland section of the Town of Kearny is a ridged community with Kearny Avenue acting as the main ridge dividing the Town in two (2) basic drainage areas. The westerly drainage area of the Town is bounded by the Passaic River and discharges the storm water flow into the said Passaic River. The easterly drainage area of the Town discharges into the Hackensack Meadowlands Development Commission's District through various swales that are tributaries to both the Passaic River and the Hackensack River. Along each side of the ridge line which separates the two major drainage areas, there is an undulation in the topography which creates small drainage basins within each of the major drainage areas.

The Town of Kearny ranges in elevation on the eastern slope of the community from a low elevation of approximately minus four point five (-4.5) feet above Mean Sea Level (MSL) to a high elevation on Kearny Avenue of approximately one hundred and fifty (150) feet above MSL as depicted on **Figure 2,** entitled, "**Topographic Map.**" These elevations were taken from maps published by the U.S. Geological Survey for the Orange, Weehawken, Elizabeth and Jersey City Quadrangles, and are based on the National Geodetic Vertical Datum (NGVD) of 1929. The western slope of the Municipality has a similar range in elevations with Kearny Avenue again being the high point and the Passaic River being the low point.

The uplands portion of the Municipality is primarily residential in nature with commercial establishments along the southern portions of Passaic Avenue, Schuyler Avenue and the entire length of Kearny Avenue. The density of development is such that the impervious ground cover is considerable and the consequent precipitation runoff is greater than those less densely developed municipalities.

The topographic features of the land within a given parameter is of primary importance in a storm drain study since it has a direct effect on the analysis of any existing system or the formulation of drainage criteria for any proposed relief system.

The concept of storm and sanitary sewers is such that they are designed for gravitational flow, where possible. That is to say, to convey waters from points of higher elevation downstream to points of lower elevation. Thus, it can be seen that the topography of the land has a very important effect on the design of any storm or sanitary system. In essence, these systems follow the basic topography of the land, thereby, the slope of the lines by the topographic conditions. Construction and size of the line required to carry the anticipated flows is dictated. Existing streams, brooks, channels and swales are also part of the drainage system of any community and they follow the natural courses determined by the general topography. The topography of the existing systems starting at Passaic Avenue on the west or Schuyler Avenue on the east and continuing northward is gently sloping and in areas it is practically flat, with some sections being back pitched. However, the grades rise sharply when proceeding toward the peak along Kearny Avenue.

The study area consists of residential development in the immediate area east of Schuyler Avenue with some commercial establishments, athletic fields, Department of Public Works Complex, scattered industrial and warehouse establishments and various landfills that have been closed and capped.

The area known as the Kearny Marsh makes up about one half of the total study area. This tract contains an elaborate system of swales, canals, culverts and lift stations that were formerly maintained by the Hudson County Mosquito Commission for the purpose of collecting the storm water runoff for the uplands areas, storing and ultimately discharging the flow into either the Passaic River or the Hackensack River. **Figure 3** entitled "**Hudson County Mosquito Commission Map**" depicts these features. This area is predominately flat and inundated by surface waters. Average elevations vary from a low of –4.5 MSL to a high of 9.0 MSL.

Recent aerial topography reveals that the study area has significantly been altered due to development coupled with the degradation it has experienced since the dissolution of the Hudson County Mosquito Commission Circa 1970.

Figure No. 4 entitled "**Development Map**" is an aerial view of the subject areas which combines the present day features with those existing prior to the dissolution of the Mosquito Commission.

V. ANALYSIS OF EXISTING DRAINAGE SYSTEM

a. General

In analyzing the present drainage system within the south-east quadrant of the Town of Kearny, it was first necessary for this office to perform an extensive field investigation to locate and monitor the existing drainage facilities. Our survey field crews traversed several streets and easements within the Town, locating and recording all drainage facilities during low and high tide conditions, as well as various storm intensity events. Maps were prepared showing the said drainage facilities, swales, pipe sizes and inlets, and are included in this report.

Simultaneously, a complete study was undertaken by our office personnel, to review all existing records of the engineering files of the Town of Kearny, as well as topographic features and aerial photographs obtained through the HMDC and various aerial mapping firms.

Depths of all drainage structures, culverts, swales and appurtenances were surveyed to provide the relationship of our sub-surface storm drains with surface configurations. Slopes of the storm drains were determined from the above data and observations. Of further consideration is the fact that any recommended improvement in this report, may require additional details of the existing drainage system and may be subject to change during the final design phase. Consideration must be given to all utility locations and sub-surface structures to be located accurately, to determine slopes and pipe sizes, and the most economic route for construction.

The existing drainage system servicing this quadrant of the Town of Kearny is complex and intricate. The system is comprised of a variety of hydraulic structures, such as pipes, open channels, tide gates, culverts and natural detention/retention basins, and at one point, a series of lift stations that have been abandoned over the years. It begins in the upper reaches in the area of Kearny Avenue and collects through a series of individual systems, which then discharges into open channels located east of Schuyler Avenue.

Figure No. 5 entitled "**Mini-System Drainage Area Map**" breaks down the study area into sub-systems, for the purpose of depicting the various tributary drainage areas. These mini-systems are described as follows:

b. **Dead Horse Creek System**

The Dead Horse Creek system consists of the drainage area bounded by Wilson Avenue on the north, Dukes Street on the south, Devon Street on the west and Bergen Avenue and Franks Creek on the east.

The area west of Schuyler Avenue is comprised of predominately residential dwellings with some commercial, warehousing and industrial establishments in the low lying areas. This area is mostly built-up with very little green space remaining.

We began our study by concentrating on this system, because of the repeated flooding problems that have occurred over the past thirty (30) years.

Several attempts were made to provide temporary relief to the Mebane Packaging Group, (formerly Wilcata Box) Warehouse and to those residents along Dukes Street, Tappan Street, Hoyt Street and Devon Terrace, east of Schuyler Avenue with little success. In August of 2000, we were successful in locating the 30" Culvert Pipe that existed under the Erie Lackawanna Railroad Embankment. Apparently lack of maintenance and siltation caused this culvert to be clogged, forcing the runoff to be retained in the area west of the Erie Lackawanna Railroad, Harrison and Kingsland Connecting Branch.

With the assistance of National Water Main Cleaning Company we were able to free this culvert and allow this area to drain easterly into the Dead Horse Creek. In addition, the Town of Kearny contracted the services of Cali-Safe Environmental to clean some of the swales that existed prior to the dissolution of the Hudson County Mosquito Control Commission and dredge a portion of the Dead Horse Creek, thus providing some minor relief to the Wilcata Box Area.

Additional relief can be re-established in this mini-system by implementing those measures recommended in the Phase IIB and IIC of the sewer separation program. This project is presently being bid and consists of separating the sanitary sewage from the storm water flow. At this present time, the sanitary and storm systems are combined. During rain fall events, those flows integrate and the excess is discharged thru overflow chambers into the drainage swales, which ultimately become tributaries to the Passaic River. The IIB and IIC Program will eliminate the combined sewer overflow chamber, will provide separate sanitary and storm water systems, and will increase the existing storm pipes to handle as a minimum the twenty-five (25) year storm frequency events. The discharge point located east of the Erie Lackawanna Railroad Harrison and Kingsland Connecting Branch, will house a headwall structure with tide gates, to prevent tidal waters from backing into the new pipe and surcharging the system.

c. **Bergen Avenue System**

The Bergen Avenue system consists of the drainage area bounded by Garfield Avenue on the north, Wilson Avenue on the south, Devon Street on the west and Frank's Creek on the east.

The area west of Schuyler Avenue is comprised of predominately residential dwellings, with a hospital and some commercial establishments along Bergen Avenue. The area east of Schuyler Avenue is predominantly comprised of industrial and warehousing establishments.

The upland section of this system is mostly built-up with very little green space remaining. Approximately half of the low-lying section is open space available for future development.

The Town of Kearny recently completed a sewer separation program for this mini-system. Prior to the undertaking of this program, the sanitary sewer and the storm sewer systems were combined. These systems were separated by constructing a network of storm and sanitary sewer pipes that collected the sanitary flow and conveyed it to the Passaic Valley Sewerage Commissioners (PVSC) trunkline, while the remaining storm water was collected and discharged into Dead Horse Creek.

The stormwater phase of this sewer separation entailed having to construct a new 4.5' high X 5.0' wide box culvert parallel with an existing box culvert along Bergen Avenue. This new culvert discharges through a tide gate, mounted in a headwall located on the north bank of Dead Horse Creek, near the junction with the Erie Lackawanna Railroad Newark and Hudson Branch.

The existing culvert diverges slightly to the north and discharges into Franks Creek in the vicinity of the above headwall.

We have monitored this newly installed system following recent rainfall events and noticed that the Bergen Avenue area did not experiencing any flooding conditions. By implementing the above improvements, we have removed the stormwater flow from entering the PVSC System, which adheres to the State of New Jersey Department of Environmental Protection (NJDEP) mandate and also saves the Town of Kearny from paying to treat clean water.

d. **Frank's Creek System**

The Frank's Creek system consists of an irregular shaped drainage area. The area is bounded by Garfield Avenue, Bergen Avenue, Erie Lackawanna Railroad Co. Harrison-Kingsland Connecting Branch and the Passaic River on the south, Stover Avenue and a point midway between Quincy Avenue and Oakwood Avenue on the north, Devon Street on the west and Interstate Route 280 and the Kearny Marsh on the east.

The physical make-up of this area is similar with the two previous described systems, where the uplands consists predominately of residential dwellings and the low lying areas consist of commercial, industrial and warehouse establishments. The area east of the Erie Lackawanna Railroad Harrison and Kingsland Connecting Branch which is bordered by the Kearny Marsh along the north, contains the Keegan Landfill.

Within the past year, we also made a concerted effort to provide temporary relief to the flooding problems which have occurred along Garfield Avenue, John Hay Avenue and Gunnel Oval. Once again, we utilized the services of Cali-Safe Environmental to clean the upper reaches of Franks Creek. The purpose of this dredging was to widen the drainage canal in order to re-establish positive pitch, thus allowing surface water to flow south into the Passaic River.

This operation was halted in the vicinity of the Keegan Landfill due to the concern of possible contamination in the area. Any disturbance within a contaminated area would require laboratory testing and NJDEP approvals, to protect the safety of the workers and the public.

We would like to emphasize at this time that these efforts are only temporary measures and more permanent solutions will be discussed further in the sections of this report that follow.

e. Gunnel Oval System

The Gunnel Oval system consists of the drainage area bounded by the Erie Lackawanna Railroad, N.Y. and Greenwood Lake Branch on the north, Pavonia Avenue through Stover Avenue on the south, Belgrove Drive on the west and the Erie Lackawanna Railroad Harrison-Kingsland Connecting Branch on the east.

The physical make-up of this area is predominately residential in nature, with some commercial and industrial establishments along Schuyler Avenue and an athletic complex east of Schuyler Avenue.

This mini-system is primarily all built-up with the exception of the aforementioned athletic fields which make up the majority of the green space.

This area along the railroad, east of the athletic fields, contained a drainage swale that conveyed storm water runoff in a southerly direction, through a culvert under the Railroad and discharged into the Kearny Marsh. This swale was recently filled and the area was graded to provide additional parking for the athletic fields. The affect of this action amplified the flooding of the perimeter roadway and the lower portions of the athletic fields during low intensity rainfall events.

Other contributing factors to the flooding problem in this area is the clogging of the railroad culvert which restricts the runoff from draining into the Kearny Marsh and the siltation of the Kearny Marsh which has caused a rise in the water level as well as loss of storage capacity. Again, this will be further explained in the sections of this report that follow.

f. Kearny Marsh System

The Kearny Marsh system consists of the drainage area bounded by the Erie Lackawanna Railroad, NY and Greenwood Lake Branch on the North, the Erie Lackawanna

Railroad Company Newark and Hudson Branch on the South, the Erie Lackawanna Railroad Harrison-Kingsland Connecting Branch on the west and the Belleville Turnpike on the east.

The entire area is a swampy bog that is inundated making it unsuitable for development.

The NJDEP Freshwater Wetland Maps classifies the entire tract as a palustrine, emergent, diked/impoundent. In referring to the **Hudson County Mosquito Commission Map, Figure 3**, the above classification is an accurate representation of the topographic condition of this mini-system.

In the past, prior to the recent development of the low lying areas of the Town of Kearny, this area was utilized as a detention system. Stormwater runoff from the upland was detained and ultimately conveyed, through an elaborate network of drainage swales and culverts, into the Passaic River.

However, as previously mentioned, since the dissolution of the Hudson County Mosquito Commission in the early 1970's, these swales and culverts have not been maintained, thus a combination of siltation and filling due to development has made this system inoperable.

In our opinion, improvements to this mini-system is one of the key sources in solving the flooding problems by re-establishing the natural retention capabilities to the area.

g. Harrison Avenue System

The Harrison Avenue System consists of the drainage area bounded by Dukes Street on the north, the Passaic River on the south, the Erie Lackawana Railroad Company – Harrison/Kingsland Connecting Branch on the east and Frank E. Rodgers Boulevard on the west.

This is a highly built-up system which contains a mixture of residential dwelling units, multi-story apartment complex, commercial, industrial and warehouse establishments with little green space remaining for development.

The area has a series of stormwater pipes that converge into a 60 inch interceptor and feeds the existing Harrison Avenue pump station, located on the north side of Harrison Avenue, immediately east of the Erie Lackawanna Railroad Harrison-Kingsland Connecting Branch. The station contains two Fairbank Morse propeller type pumps, each with a design capacity of 34,000 gallons per minute (GPM). The purpose of this station is to lift the stormwater flow from the 60" pipe, across Harrison Avenue and discharge through two tide gates into Franks Creek. From this point the stormwater flows by gravity, in a southerly direction, through another set of tide gates into the Passaic River.

Both of the original pumps have exhausted their useful life and were recently replaced with two, new propeller type pumps that were modified to increase their efficiency.

The tide gates were also recently serviced; however, they require routine maintenance. A program must be implemented to assure they are kept in proper operation, or the tidal influence from the Passaic River will further impact the flooding problems.

VI. TECHNICAL ENGINEERING DATA

a. General

This section will provide an engineering analysis of the peak flows that can be anticipated, based on varying storm frequency events. It shall be noted that for the purpose of this study, the twenty-five (25) year storm frequency was utilized, and our reasons are detailed further in this section of the report.

We performed drainage calculations for each of the previously described mini-systems, to estimate the peak amount of the runoff that will be generated, in order to size any of the proposed improvements. **Table 1** entitled **"Mini-System Stormwater Flow Estimate"** summarizes the drainage area (A) in acres, along with the peak runoff rate (Q) in cubic feet per second, for each of the respective mini-systems, for the 1, 2, 5, 10, 25, 50 and 100 Year Storm Events. **Table 2** entitled **"Rainfall Intensity Chart, New Jersey, 24 Hour Rainfall"** was used to derive the rainfall intensity for each of the above storms. **Figure 5**, entitled "**Mini-System Drainage Area Map**", depicts the drainage area (A) and runoff rate (Q) for the twenty-five (25) year storm, for each of the respective mini-systems.

b. Hydrology

The hydrological and meterological factors are basic to any storm sewer study for a particular geographic location. The usual source of such information is available from Federal, State, County, or in some instances Local Governmental Agencies. The major source of this data; however, is usually found in Federal and State Governmental Agencies where staff and funds for the accumulation of data is more readily available than on a County or Local Level.

Precipitation, as defined earlier in this report, is the deposition of moisture upon the earth's surface, and is of course, of paramount importance to the engineer in the analysis or design of any storm drainage system. The precipitation varies in extreme amounts and frequencies over the earth's surface. Through the compilation of data over many years of State and Federal Agencies, it can be anticipated within our geographic region that approximately forty-seven (47) inches of rainfall will occur within any given year, with the greatest amount of precipitation to be expected during the mid and late summer months. While the overall precipitation experience of a geographic location is of importance, a meaningful analysis can only be made when the precipitation data is scrutinized further to reflect rainfall intensity, duration and storm frequency.

TABLE 1

KEARNY DRAINAGE STUDY & ANALYSIS
MINI SYSTEM STORMWATER FLOW ESTIMATE

MINI SYSTEM	C-VALUE	AREA (ACRE)	Estimated Flow Q (cfs) 1-Year	2-Year	5-Year	10-Year	**25-Year**	50-Year	100-Year
1. Gunnel Oval System	0.65	186.83	327.89	400.75	522.19	643.63	**692.21**	777.21	910.80
2. Frank's Creek System	0.55	318.06	472.32	577.28	752.21	927.14	**997.12**	1119.57	1312.00
3. Kearny Marsh System	0.60	456.07	738.83	903.02	1176.66	1450.30	**1559.76**	1751.31	2052.32
4. Bergen Avenue System	0.65	95.99	168.46	205.90	268.29	330.69	**355.64**	399.32	467.95
5. Dead Horse Creek System	0.60	108.42	175.64	214.67	279.72	344.78	**370.80**	416.33	487.89
6. Harrison Avenue System	0.65	364.45	639.61	781.75	1018.64	1255.53	**1350.29**	1516.11	1776.69
		TOTAL	2522.75	3083.37	4017.71	4952.07	**5325.82**	5979.85	7007.65

Rainfall Intensity Data

I (1-Year) = 2.7 in/hr
I (2-Year) = 3.3 in/hr
I (5-Year) = 4.3 in/hr
I (10-Year) = 5.3 in/hr
I (25-Year) = 5.7 in/hr
I (50-Year) = 6.4 in/hr
I (100-Year) = 7.5 in/hr

Based on Hudson County, North Jersey Rainfall Curve

TABLE 2

KEARNY DRAINAGE STUDY AND ANALYSIS

RAINFALL INTENSITY CHART

NEW JERSEY 24 HOUR RAINFALL

County	1 yr	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
Atlantic	2.8	3.5	4.5	5.5	6.2	6.8	7.6
Bergen	2.7	3.3	4.3	5.3	5.7	6.5	7.5
Burlington	2.8	3.4	4.4	5.3	6.0	6.6	7.4
Camden	2.8	3.4	4.4	5.3	5.9	6.6	7.4
Cape May	2.9	3.5	4.6	5.6	6.3	6.9	7.7
Cumberland	2.8	3.4	4.5	5.4	6.0	6.8	7.5
Essex	2.7	3.3	4.3	5.3	5.7	6.4	7.5
Gloucester	2.8	3.4	4.4	5.3	5.9	6.6	7.4
Hudson	2.7	3.3	4.3	5.3	5.7	6.4	7.5
Hunterdon	2.6	3.2	4.2	5.0	5.7	6.5	7.3
Mercer	2.7	3.3	4.3	5.2	5.8	6.4	7.5
Middlesex	2.7	3.3	4.3	5.2	5.9	6.4	7.5
Monmouth	2.8	3.4	4.4	5.3	6.0	6.5	7.5
Morris	2.6	3.3	4.3	5.2	5.7	6.5	7.5
Ocean	2.8	3.5	4.5	5.4	6.2	6.6	7.5
Passaic	2.6	3.3	4.3	5.4	5.7	6.5	7.6
Salem	2.8	3.3	4.4	5.3	5.9	6.6	7.4
Somerset	2.7	3.3	4.3	5.2	5.7	6.5	7.5
Sussex	2.6	3.2	4.2	5.0	5.7	6.6	7.5
Union	2.7	3.3	4.3	5.3	5.8	6.4	7.5
Warren	2.6	3.2	4.1	4.9	5.6	6.5	7.2

Exhibit 2-NJ2

Revised March 1978

Rainfall intensity is the rate in which the water is deposited upon the land surface. It is usually expressed in inches per hour. It is generally considered that the intensity of the rainfall varies inversely with time, that is to say that storms of short time intervals tend to deposit water on the land surfaces at a faster rate then those of extended intervals.

c. **Duration**

The duration of a storm is also of importance to the engineer since it defines the time of influence a particular storm pattern may affect a given area. The duration of any storm is an expression of time and is usually measured in minutes.

The relationship between storm duration and rainfall intensity is of extreme significance in the flooding experiences of any particular geographic location. It can be seen that a particular drainage system may be equally taxed by a high intensity storm of short duration as well as a lower intensity storm of a longer duration. A primary example of a short duration high intensity storm would be a severe thunderstorm such as are frequently experienced in this area during the summer months. It can also be seen that storms of longer duration and less intensity can also cause flooding. The duration of a given storm can affect the runoff characteristics of the soil which, in turn, could significantly influence the amount of runoff that must be handled by a particular drainage system. Quite obviously, a soil in a saturated condition will produce more runoff after becoming saturated than prior to becoming saturated. Long duration storms accompanied by winds of a status to be classified as hurricanes or cyclones are also of particular note since they usually combine the characteristics of a short and long duration storm. The problem is compounded further since such storms are usually accompanied by abnormal tidal fluctuations which adversely affect the drainage capabilities of community such as the Town of Kearny. Recent examples of the types of storms described above were experienced on July 8, 1994 and Hurricane Floyd in September 1999.

From the above, it can be seen that any design or analysis must be predicated on a relationship between rainfall intensity and storm duration.

d. **Frequency**

The frequency of a storm represents the probability of return of a storm of a particular rainfall intensity and duration, based on a review of historical statistical data. That is to say, the probability of reoccurrence is based on the past occurrence record of a storm of particular rainfall intensity-duration characteristics. The frequency then actually indicates the average frequency and implies an average reoccurrence interval. It should be clearly understood that the frequency does not imply that a storm would occur at a regular frequency interval. If for instance we consider a storm having a ten (10) year frequency, it should not be anticipated that this would occur at a regular ten (10) year interval but rather a storm of this intensity and magnitude, based on past history, may occur ten (10) times in a given one hundred (100) year period. It is not unlikely that in any given year, several ten (10) year storms may be experienced.

The above was very pointedly illustrated during past storms. For example, on August 27 and 28, 1971, we experienced a storm accompanying Hurricane Doria that has been determined to have a frequency of occurrence of probably once in one hundred and twenty (120) years. Less than three (3) weeks later; however, on September 11 and 12, 1971, we experienced another storm that had a frequency of occurrence of probably in excess of once in every sixty (60) years. Then on July 8, 1994, we experienced one that has been determined to have a frequency of occurrence of once in one hundred (100) years. Lastly on September 17 through 23, 1999, we experienced a storm that had a frequency in excess of once in every five hundred (500) years . This latter experience very pointedly illustrates that long term frequency storms can be experienced in close proximity to one another.

In analyzing and designing storm sewer systems, there are available rainfall intensity-duration frequency curves applicable to our general area that have been promulgated by various Federal and State Agencies and these are the industry's standards for design. The data from these curves has been used by this office in our analyses and design criteria determinations.

Before any analysis or design can be undertaken, a determination must first be made as to the particular storm frequency, which will become the criteria for all evaluations. The determination of selecting storm frequency base is usually made on the economic worth of the properties, probable storm damage and traffic movement as balanced against the cost of construction for providing a particular degree of protection. In this particular area, it has been generally determined by the Residential Site Improvement Standards of the New Jersey Administrative Code, Title 5, Chapter 21, that a twenty-five (25) year frequency storm would provide the protection commensurate with the consideration listed above. We have eliminated the comparison between various storm frequency designs as was performed during the Phase I analysis. It was determined that the degree of protection provided by the construction of storm sewers based on a twenty-five (25) year storm frequency design was significantly more cost effective than the protection afforded by a fifteen (15) year storm frequency design, as promulgated by the Code of the Town of Kearny Section 127-50 c(5) and a five (5) year storm frequency-thirty (30) minute duration design as required by the Hudson County Planning Board in their resolution entitled "Hudson County Subdivision and Site Plan Review and Approval," dated December 1992.

e. Hydraulics

There are several hydraulic methods that may be utilized in analyzing or designing a storm sewer system. One of the more common and popular methods of analysis is known as the Rational Method. The rational method is expressed mathematically by the formula Q=CIA where

Q = flow or peak runoff rate, in cubic feet per second (cfs). The flow generated from the total drainage area tributary to the point under consideration

C = Dimensionless runoff coefficient or ratio of runoff to rainfall. A constant intended to reflect drainage area runoff characteristics including land use, impervious cover, soil type, etc. Represents the percentage of peak producing rainfall that will become runoff;

I = Uniform rainfall intensity for selected storm duration and frequency, in inches per hour, as determined from the Rainfall Intensity-Duration-Frequency curves, storm duration is set equal to drainage area time of concentration (TC), which is the time required (under peak runoff conditions) for runoff to flow from the hydraulically most distant point in the drainage area to the point of Analysis.

A = drainage area, in acres, tributary to the point of consideration.

While the drainage area can be accurately determined by topographic maps and field observations and the intensity of rainfall as was explained earlier is provided for by the rainfall intensity-duration frequency curves compiled from data promulgated by government sources, the runoff coefficient C has to be determined by visual observation of the particular drainage area. The rate or runoff resulting from any particular storm is dependent upon many variable factors, the type of soil, the ground cover, the surface improvements, the season of the year, the type of weather preceding the storm, the intensity and duration of the storm and the topography of the land are all part and parcel in determining the amount of runoff a given drainage area will contribute. While there are charts, that have been promulgated based on past experiences in this and other areas, and are available to the engineer for his determination of the runoff coefficient, these charts still must be tempered by the judgment and experience of the design engineer.

The present systems can only handle the equivalent of a 1 to 2 year storm frequency. It is our opinion that the systems capacity has been drastically reduced over the last twenty-five (25) to thirty (30) years due to the construction of the landfill, the lack of maintenance and added runoff from development. This can graphically be seen on **Figure 4, Development Map** which is part of our presentation. The construction of the landfill drastically impacted the existing drainage patterns in the Kearny Marsh Area, because it filled approximately one hundred (100) acres or one quarter of the Kearny Marsh System, thus reducing the storage volume that was once available to the entire study area.

In the early 60's, the area where the Keegan Landfill is presently located, was a drainage basin comprised of a system of swales that collected the stormwater runoff from the upland area, west of the Erie Lackawanna Railroad Harrison-Kingsland Connecting Branch and conveyed it into Frank's Creek.

We have conservatively estimated the potential storage for storm water in the Keegan Landfill section of the Kearny Marsh to be approximately one hundred (100) acre-feet, which is equal to twenty-five (25) football fields, three (3) feet deep.

In 1972 when the landfill was closed down, aerial photographs show that the landfill changed the course of water which flowed through this area. The previous open system of swales and railroad culverts was virtually eliminated by the landfill. This created a wedge which blocked the drainage from the upland and Kearny Marsh systems, thus raising the water elevation in the Kearny Marsh, which in turn caused flooding along the fringes of the developed areas.

Clearly, as we continue to analyze all the mini-systems components of this drainage area, there exist one common problem, the lack of storage in this area was reduced by the filling operations from the Keegan Landfill, the Devon Manor, the Gunnel Oval and the Harvey Field Area, which in turn caused siltation, thus clogging the various railroad culverts downstream of these sites.

VII. RECOMMENDED IMPROVEMENTS

Within the overall drainage area we recommend several improvements be made so that the system can handle, as a minimum, the 25 Year Storm Frequency Event.

Please note that should the Town of Kearny experience a higher Frequency Storm coupled with high tides, these areas will continue to flood, along with various other sections of the Town. To eliminate any chance of flooding would not be financially feasible. The design storm frequency of one in 25 years should provide substantial relief.

The following is a list of recommended improvements that will provide relief to the reoccurring flooding problems within the study area. These recommendations are graphically depicted on **Figure 6** entitled "**Recommended Improvements Map**".

➢ Dead Horse Creek System

The Town has recently accepted bids for the Phase IIB & IIC Sewer Separation Program, which is designed to upgrade the existing undersized storm pipe, and will separate the combined sanitary and storm sewer flows within this mini-system. The work will begin at Schuyler Avenue and extends east along Tappan Street, through the easement on the All Seasons Movers Property under the Erie Lackawanna Railroad (Harrison-Kingsland Branch) and will discharge through two (2) proposed tide gates into Dead Horse Creek.

We recommend that the Dead Horse Creek be dredged and channelized with Gabion Sidewalls from the above tide gates to the point where it converges with Frank's Creek. Also, the drainage swale that parallels and is located west of the Erie Lackawanna Railroad Co. (Harrison-Kingsland Branch) should be dredged and channelized with Gabion Sidewalls. Any dredge material that is removed from this area can be disposed at the Keegan Landfill, in order to minimize transportation and disposal costs. This is predicated on the assumption that the concentration levels of the dredge material is within permissible standards.

The culvert under the Erie Lackawanna Railroad Co. Branch "A" (Newark and Hudson Branch) should be upgraded to a 20 wide by 4 high box culvert. This will have sufficient capacity to convey the anticipated flows from both the Bergen Avenue Mini-system and the Dead Horse Creek Mini-system, as depicted on **Table 1** entitled "**Mini-system Stormwater Flow Estimate**".

Lastly, in our opinion, a floatables separation chamber should be installed on the proposed storm culvert, in the area west of the Erie Lackawanna Railroad (Harrison-Kingsland Branch), this chamber will act as a collection point for all floatables that enter the storm system, and allow personnel to access this chamber to routinely remove these materials from the system.

➢ Bergen Avenue System

As previously indicated, the combined storm and sanitary systems were separated and a new storm culvert was installed along Bergen Avenue, conveying the runoff from the upland reaches into Dead Horse Creek.

The only modification we recommend is to install a floatables separation chamber on the existing box culvert, at a point upstream of the tide gates/headwall structure to provide an access point for the removal of any debris that enters the system.

➢ Frank's Creek System

This Mini-system is the main trunkline that collects the runoff from all the other five mini-systems and conveys the flow through the tide gates, into the Passaic River. This system will require the most improvements.

The existing metal, flap type tide gates and headwall structure should be replaced with new rubber check valves similar to the recently installed system on Bergen Avenue. The rubber valves are more efficient in preventing backflow from the Passaic River surcharging Frank's Creek, and they will also reduce the amount of maintenance required by the conventional flapgates. Furthermore, these tide gates should be relocated on the Passaic River side of the Pennsylvania Railroad, Conrail Co., United New Jersey Railroad and Canal Tracts. A new floatable separation chamber should be installed in place of the existing tide gate structure located on the north side of the above referenced railroad.

Secondly, we recommend that the entire length of Frank's Creek from the above tide gates to the John Hay Avenue flume be dredged to obtain positive pitch. From the tide gates to the proposed pump station, install a concrete lined swale and from the proposed pump station to the John Hay Avenue flume, install Gabion Sidewalls with a natural bottom. This rechannilization will increase the conveyance capacity of Frank's Creek. Furthermore, we anticipate that any dredge material that is removed from this area, can be disposed at the Keegan Landfill in order to minimize transportation and disposal costs.

The remains of the former pump station located along the unimproved section of Bergen Avenue, north of Harrison Avenue, should be excavated and removed to avoid constricting that portion of Frank's Creek, and a new lift station should be constructed in its place. The purpose of this lift station is to assist in the conveyance of runoff within Frank's Creek, following high intensity-short duration storm (Flash Storm) and help maintain the low levels in the system by allowing the drainage swales to be drained. Please note that it would be cost prohibitive and impractical to construct a lift station capable of handling the runoff for the entire 25 Year Storm Event, from all five of the contributing drainage areas. This equates to a flow of approximately 4,000 cfs and would require a pump station that is thirty times the size of the Harrison Avenue Pump Station.

The new lift station must contain as a minimum, three (3) propeller type pumps, each rated for a capacity of 60,000 GPM with provisions for the collection of floatables. These pumps will convey the anticipated flow from the one year storm event for the Frank's Creek Mini-system, and as previously stated, assist in the draining of the Kearny Marsh following a substantial rainfall event.

Furthermore, we recommend that a control structure be installed within the Keegan Landfill to divert the flow from Frank's Creek into the Kearny Marsh. The control structure would allow low intensity storms to be passed through Frank's Creek while diverting the high intensity storms in the Kearny Marsh for storage.

➢ Gunnel Oval System

The runoff from Gunnel Oval System previously drained in an easterly direction, into a drainage swale parallel to the Erie Lackawanna Railroad (Harrison-Kingsland Connecting Branch), which discharged into the Kearny Marsh through a culvert under the railroad tracks.

Recent development and filling of the above drainage swale has caused the runoff to pond along the lower reaches of this mini-system, and dissipates slowly.

As previously discussed, the collection swale was subsequently filled to provide additional parking for the Gunnel Oval Athletic Complex. This swale should be reinstated to provide a collection point for this mini-system and the following, improvement should be made to better service this mini-system.

Upgrade the railroad culvert under the Erie Lackawanna Railroad, Harrison-Kingsland Connecting Branch tracks to a 4' high X 15' wide box culvert, and install tide gates on the outflow side to prevent the backflow from the Kearny Marsh to surcharge this system.

Furthermore, since the storm drain system along the easterly side of the athletic field is fairly shallow and contains very little pitch, we recommend that a small lift station (consisting of two-4,200 GPM Pumps) be installed to assist in draining the runoff from the athletic field following a rainfall event. Be advised that the primary intent of this station is to help maintain the fields dry, after the stormwater recedes. This will allow a faster turn-around for utilizing these facilities.

➢ Kearny Marsh System

As mentioned in the previous sections of this report, the key to resolving these reoccurring flooding problems within this study area, centers around the Kearny Marsh Mini-system.

During the existence of the Hudson County Mosquito Commission, this network of drainage swales and culvert was regularly maintained, which allowed the stormwater to be detained within this mini-system during the rainfall event and was subsequently allowed to drain, once the downstream flow receded. It is obvious that partial filling and siltation within this area has caused a rise in the water level (of approximately three (3) feet) and the storage capacity has been depleted.

Our calculations indicate that the total storage capacity for this mini-system consists of 456 acre feet (or 456 acres-one foot in depth). If we exclude the 100 acre area taken up by the Keegan Landfill, the remaining storage capacity for this system is approximately 356 acre feet. According to Table 1, the anticipated 100 Year Stormwater Flow for the entire study area is 7,000 cfs, which correlates that should the volume generated from the 100 year storm event were to be stored in the Kearny Marsh System, the water level would raise two (2) feet in height.

Based on this analysis, we recommend that the most critical factor is to drain the Kearny Marsh and recreate the storage volume that has been lost due to development. This can be accomplished by dredging and re-creating all the former drainage swales within the Kearny Marsh System and by redirecting all the stormwater run-off from the area north of Bergen Avenue into the Kearny Marsh. It is our opinion that this system can serve as a large scale detention system for the entire Kearny Re-Development area. In order to implement this practice, we feel that the HMDC should oversee this operation. They are the governing authority for this district. It makes sense to have one large detention area and one authority to serve the entire drainage area

We encourage the HMDC further investigate this concept and create an escrow account funded by developers that would benefit by the construction of this detention facility. These funds could then be used to dredge the Kearny Marsh and construct a series of outflow structures that would control the volume of runoff to be discharged into Frank's Creek.

In addition, a maintenance program should be instituted to assure the continued operation of this facility and prevent a reoccurrences of the dumping and filling that has taken place over recent years.

- **Harrison Avenue System**

The two pumps at the Harrison Avenue Pump Stations were recently replaced; therefore, no further work is necessary to the collection system.

Our only recommendation is to replace the two metal flap type, tide gates with new rubber check valves. This will insure the pumping system will continue functioning properly and will reduce the maintenance required on the conventional flap gates.

VIII. ESTIMATE PROJECT COSTS

The estimated project costs listed in this portion of the report are provided as an indication of approximate costs and magnitude of a particular project, and are based on year 2000 construction pricing. It should be understood that when construction drawings are prepared for any particular system, it will be necessary to prepare a more accurate cost estimate. For instance, pipe sizes may need to be changed, depth of installation may have to be increased or decreased, and deviation in the selection of routes may be necessitated because of subsurface structures and conditions, which cannot be anticipated or accounted for in this type of study.

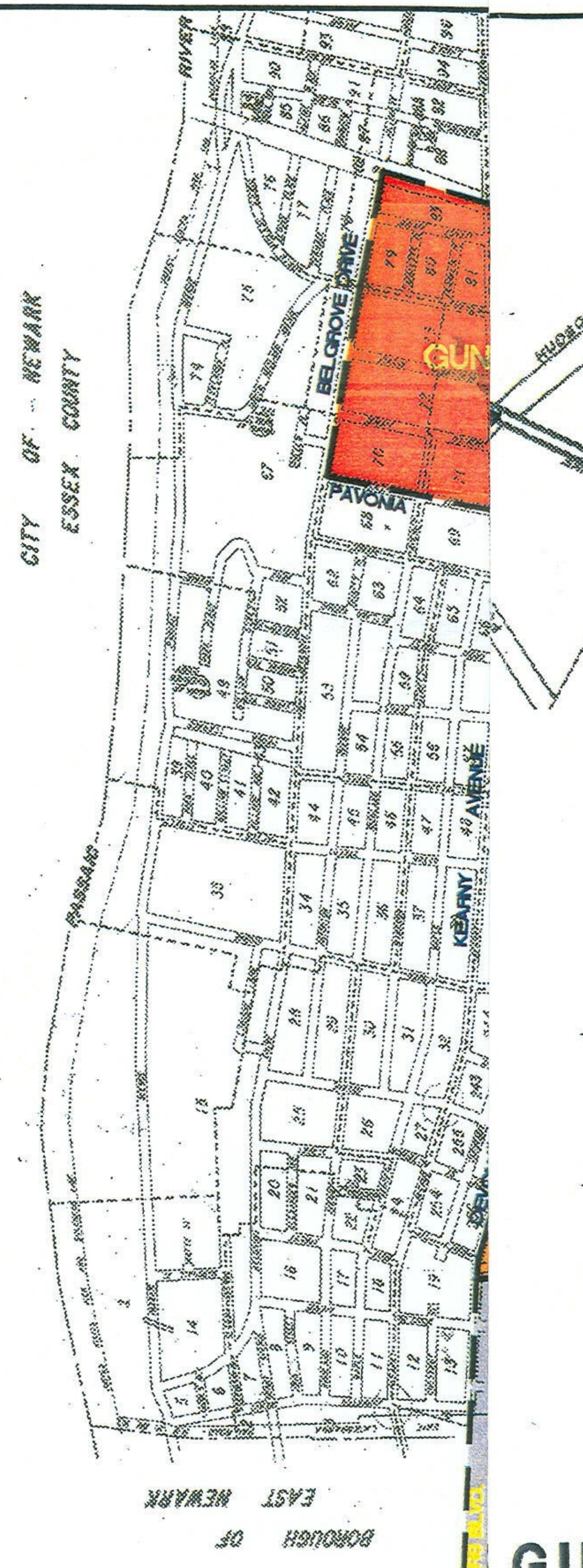
These estimates would of course be subject to inflation or future charges in construction costs.

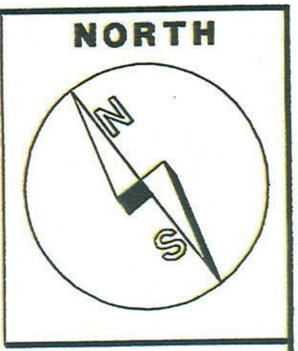
It should be noted that some right-of-way acquisitions or easements maybe required for these installations. We have attempted to be liberal with our estimates in consideration of the above uncertainties and would expect that the proposed improvements can be constructed within our estimated costs.

Furthermore, it is assumed in this report that the contamination can be limited by utilizing the Keegan landfill for a disposal site. However, the environmental clean-up cannot be accurately estimated at this point, since it requires laboratory analysis, and may well exceed the costs of these proposed drainage improvements.

Should this solution be considered, the Town of Kearny must actively seek out Government Grants or Funding that is available for remediation purposes.

Our cost analysis is comprised of six (6) categories, which mirror the mini-system improvements described in the previous sections. The following is a detailed breakdown of the construction costs for each of respective mini-systems. These improvement costs are depicted on **Figure 7** entitled **"Improvement Costs Map."**


CITY OF NEWARK
ESSEX COUNTY
PASSAIC RIVER
BELGROVE DRIVE
GUN
HUDSON
PAVONIA
KEARNY AVENUE
BOROUGH OF EAST NEWARK



MINI–SYSTEM	IMPROVEMENT COSTS
GUNNEL OVAL SYSTEM	$ 9,600,000
FRANK'S CREEK SYSTEM	$25,200,000
KEARNY MARSH SYSTEM	$ 4,200,000
BERGEN AVENUE SYSTEM	$ 600,000
DEAD HORSE SYSTEM	$ 9,600,000
HARRISON AVENUE SYSTEM	$ 600,000
TOTAL	$49,800,000

NOTE:
THE ABOVE COSTS ARE BASED ON YEAR 2000 CONSTRUCTION COSTS.

GURE 7
EMENT COSTS
N OF KEARNY
TY NEW JERSEY

1"=1200'
PROJECT NO.: 10129
SHEET NO.:
OK
DATE: NOVEMBER 2000

APPENDIX 'A'

CULVERT ANALYSIS

NEGLIA ENGINEERING ASSOCIATES
34 Park Avenue P.O. Box 426
LYNDHURST, NEW JERSEY 07071
(201) 939-8805
Fax (201) 939-0846

JOB [illegible]
SHEET NO. 1 OF
CALCULATED BY NICK [illegible] DATE 12/21/00
CHECKED BY DATE
SCALE RT 280

CULVERT ANALYSIS

NOTE: THE EXISTING 12' H X 20' W CULVERT IS LOCATED UNDER THE RT 280 EMBANKMENT

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.49}{.013} \times 240\,SF \times (3.75)^{.67} \times (.00045)^{.5}$$

$$R = \frac{A}{P} = \frac{12 \times 20}{12+20+12+20}$$

$R = 3.75$

Q = 1,414.69 CFS

FROM TABLE 1

Q_{25} FOR BERGEN AVE SYSTEM = 355.64 CFS

Q_{25} FOR DEAN [illegible] SYSTEM = 370.80 CFS

Q_{25} FOR HARRISON AVE SYSTEM
BASED ON 2 PUMPS @ 30,000 GPM

$$2\left(\frac{30{,}000\,GAL}{MIN} \times \frac{CF}{7.48\,GAL} \times \frac{MIN}{60\,SEC}\right) = 133.68\ CFS$$

TOTAL [illegible] TO CULVERT = 860.12 CFS

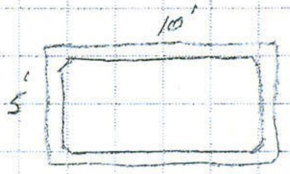
[illegible] CAPACITY TO [illegible] FROM [illegible] THE AREA [illegible]

NEGLIA ENGINEERING ASSOCIATES
34 Park Avenue P.O. Box 426
LYNDHURST, NEW JERSEY 07071
(201) 939-8805
Fax (201) 939-0846

JOB KEARNY DRAINAGE STUDY
SHEET NO. ______ OF ______
CALCULATED BY NICK VILLANO DATE 1/15/2001
CHECKED BY ______ DATE ______
SCALE HARRISON AVE

CULVERT ANALYSIS

NOTE: THIS EXISTING 5'X10' CULVERT CROSSES HARRISON AVE AT BERGEN AVE AND PARALLELS HARRISON AVE ALONG THE SOUTH SIDE OF THE ROADWAY



$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$Q = \frac{1.49}{.013} \times 50SF \times (1.67)^{.67} \times \left(\frac{-2.2-(-4.5)}{550}\right)^{.5}$$

$A = 5' \times 10' = 50SF$

$$R = \frac{A}{P} = \frac{50SF}{5+10+5+10} = 1.67$$

$Q = 522.54$

ACCORDING TO CALCULATIONS FOR CULVERT UNDER RT 280 NEED CAPACITY OF 860.12 CFS

$\therefore$ 860.12 CFS − 522.54 CFS = 337.58 CFS

$$337.58\,CFS = \frac{1.49}{.013} A R^{2/3} (0.00045)^{.5}$$

$A R^{2/3} = 138.84$

BY TRIAL & ERROR

ASSUME	Y	X	A	P	$R = \frac{A}{P}$	$AR^{2/3}$
	6	15'	90	42	2.14	147.97 > 283.16 ∴ OK

∴ USE EXIST 5'X10' CULVERT & [illegible] X15' ADJACENT TO THE STRUCTURE

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JOB [illegible] STUDY
SHEET NO. 1 OF
CALCULATED BY [illegible]
DATE 11/22/00
CHECKED BY
DATE
SCALE DEAD HORSE CREEK

CULVERT [illegible]

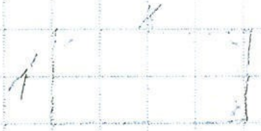
NOTE: THIS PROPOSED CULVERT [illegible] THE [illegible] OF BERRY AVE & THE [illegible] RAILROAD ([illegible]) WILL CARRY [illegible] THE BERRY AVE [illegible] & THE DEAD HORSE CREEK [illegible]. FROM TABLE 1, THESE FLOWS ARE [illegible] CFS & 374 CFS [illegible], FOR A [illegible] STORM [illegible]

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$S = \frac{\frac{2''}{12}}{60} = 0.003$$

$$727\ CFS = \frac{1.49}{.013} A R^{2/3} (0.003)^{0.5}$$

$$A R^{2/3} = 116$$



BY TRIAL & ERROR

ASSUME Y	A	P	$R = \frac{A}{P}$	$AR^{2/3}$
20'	80	4.8	R: 1.65	[illegible] ≈ 116

∴ USE 4' HIGH × 20' WIDE [illegible] CULVERT

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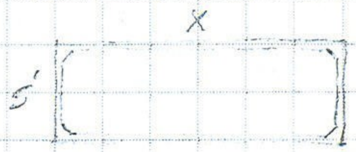
JOB [illegible]
SHEET NO. 1 OF
CALCULATED BY MIKE VILLANO DATE 12/5/00
CHECKED BY DATE
SCALE FRANKS CREEK (KEEGAN LANDFILL)

COLVERT SIZING

NOTE: THIS [illegible] IS FOR THE SECTION OF FRANKS CREEK FROM THE JUNCTION [illegible] TO THE JOHN HAY HOME APPROXIMATELY 3/4 OF THE [illegible] FLOW [illegible] 750 CFS

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$



$750\,CFS = \frac{1.49}{0.013} A R^{2/3} (0.00055)^{0.5}$

$AR^{2/3} = 279$

BY TRIAL & ERROR

ASSUME X	A	P	$R = \frac{A}{P}$	$AR^{2/3}$
15	75	40	1.875	114

[illegible] INCREASE SLOPE [illegible]

$750\,CFS = \frac{1.49}{0.013} AR^{2/3} (0.003)^{0.5}$

$AR^{2/3} = 119$

ASSUME Y	X	A	P	$R = \frac{A}{P}$	$AR^{2/3}$
[illegible]	15	[illegible]	[illegible]	2.[illegible]	150 [illegible]

[illegible] BOX CULVERT

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JOB [illegible]

SHEET NO. 1 OF

CALCULATED BY NICK [illegible] DATE 11/29/00

CHECKED BY DATE

SCALE GUNNELL OVAL

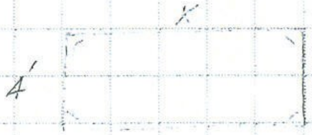
NOTE: THE PROPOSED [illegible] @ GUNNELL OVAL, [illegible] THE FLOW FROM THE [illegible] [illegible] FROM [illegible] 692 CFS FOR A 25 YR STORM EVENT

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$$S = \frac{3''/12}{50} = 0.005$$

$$692\ CFS = \frac{1.49}{.013} A R^{2/3} (0.005)^{0.5}$$

$$AR^{2/3} = 85$$



[illegible]

ASSUME X	A	P	R=A/P	$AR^{2/3}$
15'	60	38	1.58	81 [illegible] 85
16'	64	40	1.60	88

[illegible]

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APPENDIX 'B'

SWALE SIZING

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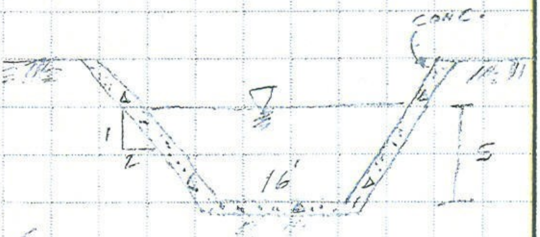
JOB [illegible] · [illegible] STUDY
SHEET NO. 1 OF
CALCULATED BY [illegible] DATE 1/12/01
CHECKED BY DATE
SCALE SECTION A-A

SWALE SIZING (A-A)

NOTE: THE LOWER PORTION OF FRANK'S CREEK MUST CONVEY THE FLOW FROM THE [illegible] AVE SYSTEM, THE DEAD HORSE CREEK SYSTEM & 133.68 CFS FROM THE HARRISON [illegible] [illegible] [illegible] (REFER TO RT 280 - [illegible] ANALYSIS) TOTAL = 860.12 CFS



$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

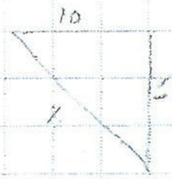
$Q = \frac{1.49}{.013} \times 130 \times (3.39)^{.67} \times (.00015)^{.5}$

$A = \frac{16+36}{2} \times 5 = 130\,SF$

$Q = 716.17\,CFS < 860.12\,CFS$

$R = \frac{A}{WP} = \frac{130}{11+16+11} = 3.39$

∴ EXISTING CHANNEL MUST BE ENLARGED

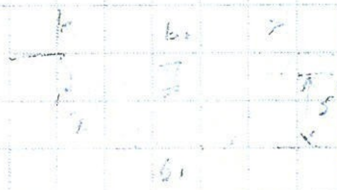


$X = \sqrt{5^2+10^2}$

$X = 11.18$

$860.12\,CFS = \frac{1.49}{.013} A R^{2/3} (0.00015)^{0.5}$

$A R^{2/3} = 353.96$



BY [illegible] & ERROR

ASSUME	b_1	b_2	$A = \frac{b_1+b_2}{2} \times h$	P	R	$A R^{2/3}$
	20	[illegible]	150	11.18 + 20 + 11.18 = [illegible]	[illegible]	[illegible]

[illegible] 353.96 ∴ [illegible]

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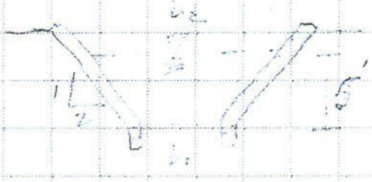
JOB [illegible] 97-07
SHEET NO. 1 OF
CALCULATED BY [illegible] DATE 11/28/00
CHECKED BY DATE
SCALE SECTION B-B

SWALE SIZING (B-B)

NOTE: THE [illegible] THE [illegible] 1 [illegible] 15 [illegible] [illegible] & [illegible] 377.[illegible] & 356 [illegible].

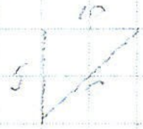


$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$??? = \frac{1.49}{0.013} A R^{2/3} (0.0004)^{0.5}$

$S = \frac{2'}{5,200} = 0.0004$

$A R^{2/3} = 577$



$5^2 + 10^2 = c^2$
$c = 11$
$5^2 + ?^2 = c^2$
$= 13.4$

BY TRIAL & ERROR

ASSUME b_1	b_2	$A = \frac{b_1+b_2}{2} \times h$	P	$R = \frac{A}{P}$	$A \cdot R^{2/3}$
10	30	100	11+10+11=32	3.[illegible]	215 < 577 NG
20	40	150	11+20+11=42	3.57	[illegible]
[illegible]	[illegible]	[illegible]	[illegible] TO 6' [illegible]	[illegible]	44.4.3
20	44	19?	[illegible]	4.10	[illegible]
25	1?	1??	[illegible]	4.1?	[illegible] OK
30	50	200	[illegible] 51	3.76	1??
40	[illegible]	[illegible]	[illegible] 56	4.4	[illegible]

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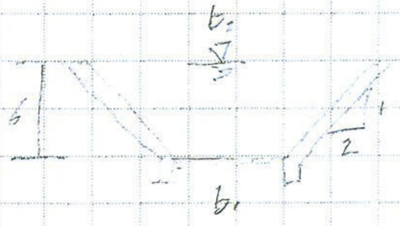
JOB KEARNY [illegible] STUDY
SHEET NO. 1 OF
CALCULATED BY NICK VILLANO DATE 12/7/00
CHECKED BY DATE
SCALE SECTION C-C

SWALE SIZING (C-C)

NOTE: THE [illegible] SYSTEM DRAINAGE MAP [illegible] APPROX. 3/4 OF THE TOTAL AREA DISCHARGE [illegible] SECTION OF FRANK'S CREEK. THEREFORE [illegible] ACCOUNT FOR 3/4 OF THE [illegible] MAIN SYSTEM FLOW BASED ON THE 25 YEAR STORM FREQUENCY = 3/4 × 999.12 CFS = 750 CFS

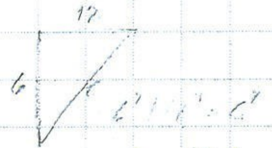
$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$



$750\,\text{cfs} = \frac{1.49}{0.032} A R^{2/3} (0.00055)^{0.5}$

$S = 0.00055$

$A R^{2/3} = 494$



$a^2 + b^2 = c^2$

$c = 13.4$

[illegible]

ASSUME	b_1	b_2	$A = \frac{b_1+b_2}{2} h$	P	$R = \frac{A}{P}$	$A \cdot R^{2/3}$
	20	44	192	46.8	4.1	494 ≈ OK

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JOB [illegible] — DRAINAGE [illegible]

SHEET NO. 1 OF

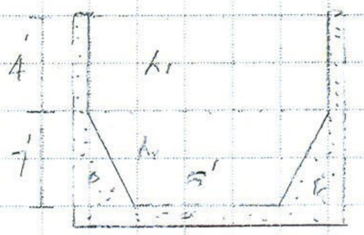
CALCULATED BY NICK [illegible] DATE 12/17/00

CHECKED BY DATE

SCALE SECTION D-D

FLUME [illegible] (D-D)

NOTE: THE [illegible] ARE BASED ON [illegible]
[illegible] & HOURS [illegible] BASED ON [illegible] OF HEC [illegible]
Q_{25} = 997.50 FOR ENTIRE [illegible] CREEK SYSTEM



$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$Q = \frac{1.49}{0.013} \times 110.5 \times (3.64)^{0.67} \times .00055^{0.5}$

$A_1 = 4' \times 11' = 44\ SF$

Q = 706 CFS < 997.50 CFS

$A_2 = \frac{8+11}{2} \times 7 = 66.5\ SF$

∴ EXISTING FLUME CANNOT
HANDLE THE 25 YR STORM
FOR THE [illegible]
[illegible]
ONLY 2/3 OF THE FLOW [illegible]
[illegible] FLUME [illegible]
REMAINING 1/3 IS [illegible]
FROM THE [illegible]
ERIE LACKAWANNA RR [illegible]
[illegible]
THEREFORE, EXISTING FLUME IS OK.

$A_{TOTAL} = 110.5\ SF$

$R = \frac{A}{P} = \frac{110.5}{4 + [illegible] + 7.2 + 4}$

R = 3.64

JOB KEARNY DRAINAGE STUDY

SHEET NO. ______ OF ______

CALCULATED BY NICK VILLANO DATE 1/16/2001

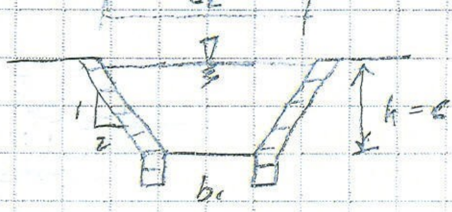
CHECKED BY ______ DATE ______

SCALE SECTION F-F

SWALE SIZING (F-F)

NOTE: THE MINI-SYSTEM DRAINAGE MAP INDICATES THAT THE GUNNEL OVAL SYSTEM GENERATES A FLOW (25 YEAR) = 692 CFS

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$



$$692 \text{ CFS} = \frac{1.49}{0.023} A R^{2/3} (0.005)^{0.5}$$

$$A R^{2/3} = 151.06$$

BY TRIAL & ERROR

ASSUME	b_1	b_2	$A = \frac{b_1 + b_2}{2} h$	P	$R = \frac{A}{P}$	$A R^{2/3}$
	16	40	168	13.4+16+13.4 = 42.8	3.93	420 > 151 ∴ OK
1ST SMALLER	10	34	132	13.4+10+13.4 = 36.8	3.59	310 > 151 ∴ OK
1ST SMALLER	4	28	96	13.4+4+13.4 = 30.8	3.12	205 > 151 ∴ OK

THE SWALE TAKES UP TOO MUCH ROOM ∴ USE ALTERNATE

A) REFER TO CULVERT ANALYSIS FOR GUNNEL OVAL & USE

A 4'X15' BOX CULVERT @ 0.5% SLOPE

OR

B) REFER TO SWALE SIZING ANALYSIS FOR SECT D-D & USE

AN 11' WIDE X 11' HIGH FLUME

RECOMMEND "B" - W/ INLETS ALONG RR ROW

APPENDIX 'C'

PHOTOGRAPHS

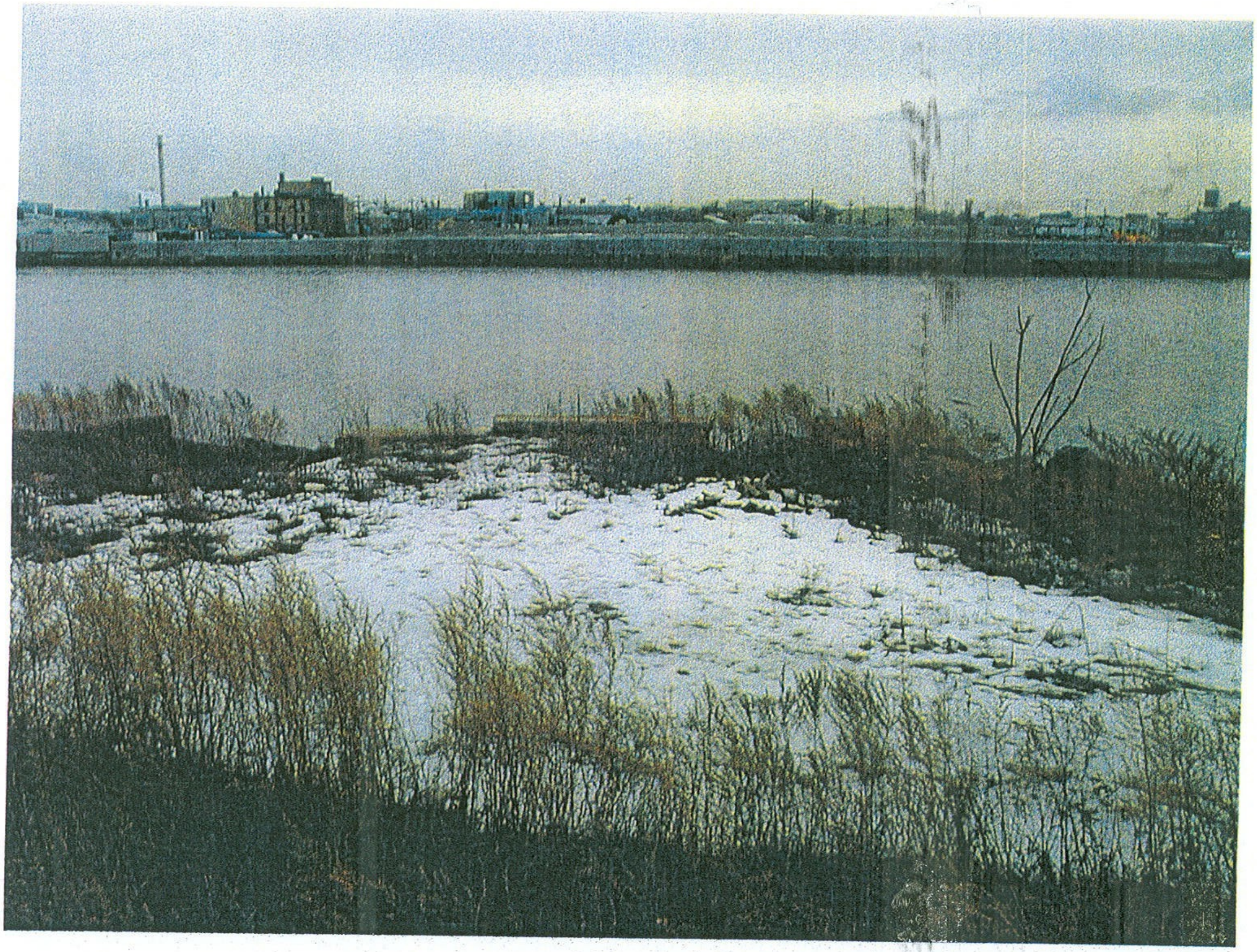


Photo No. 1

Looking south at the existing Passaic River headwall, in the area of proposed tide gates and headwall

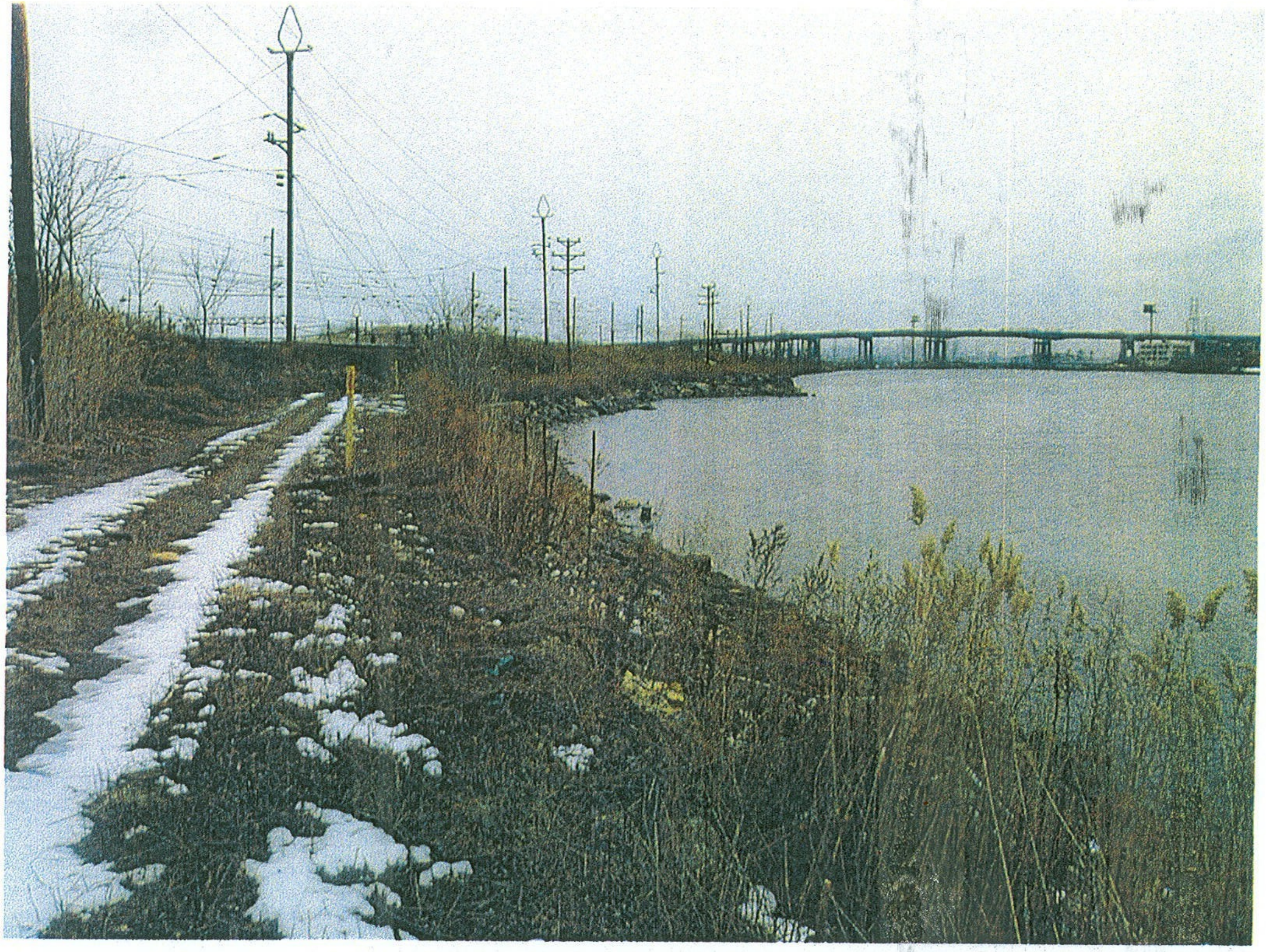


Photo No. 2

Looking east along the Passaic River, in the area of the proposed tide gates and headwall

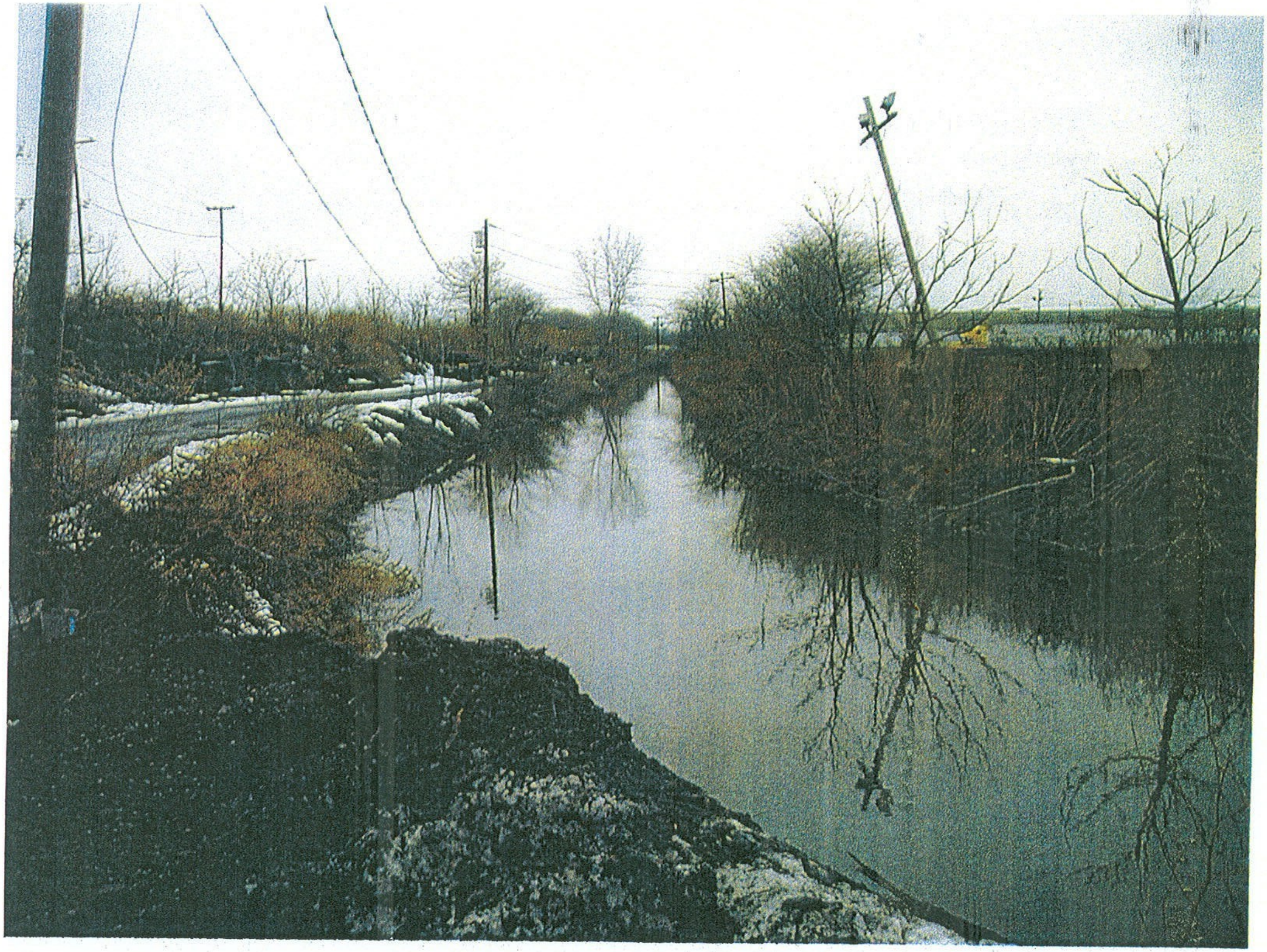


Photo No. 3
Looking north along Frank's Creek, from the Linde-Griffith Construction Company yard

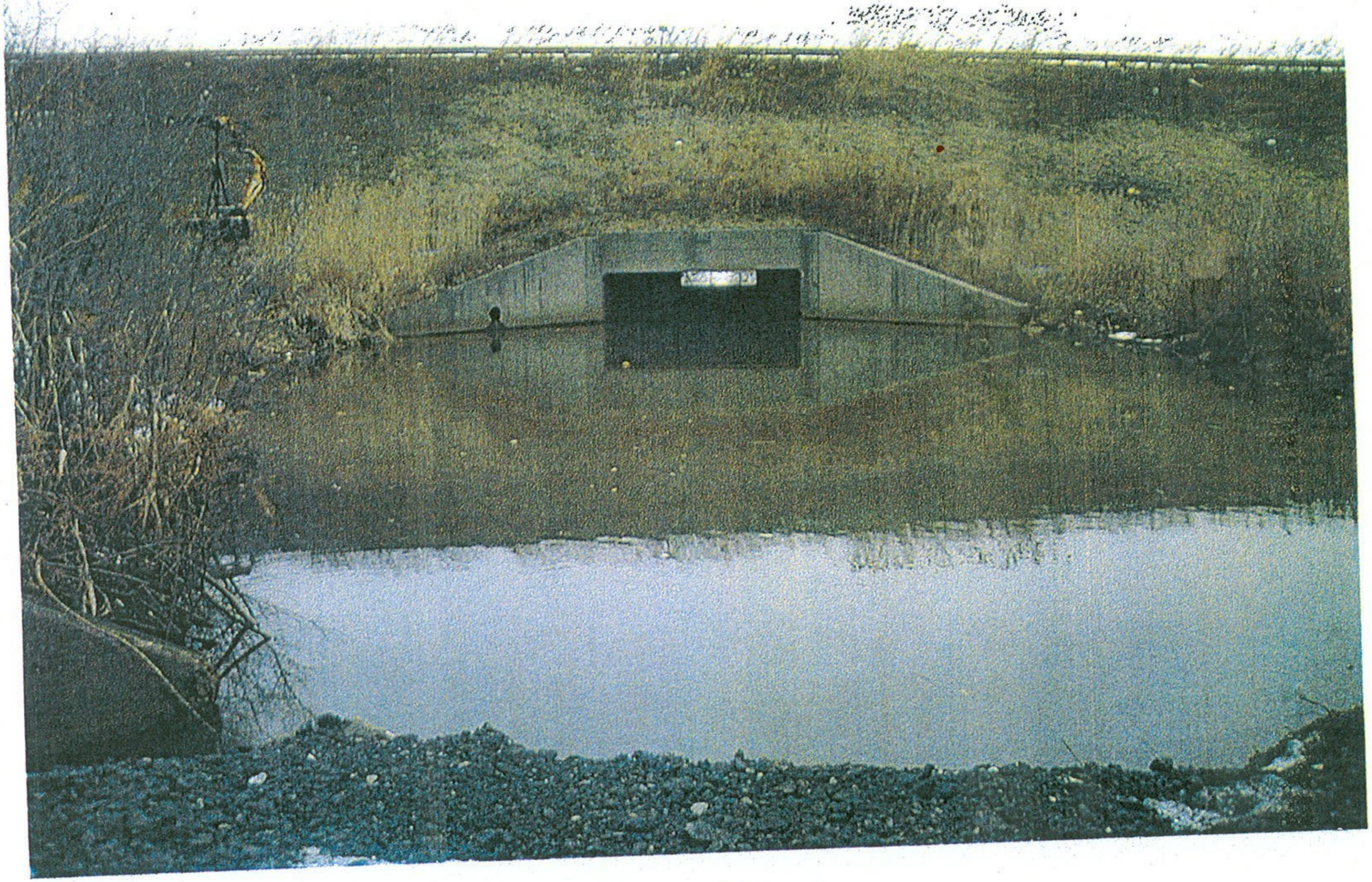


Photo No. 4

Looking north along Frank's Creek, at the Route 280 culvert

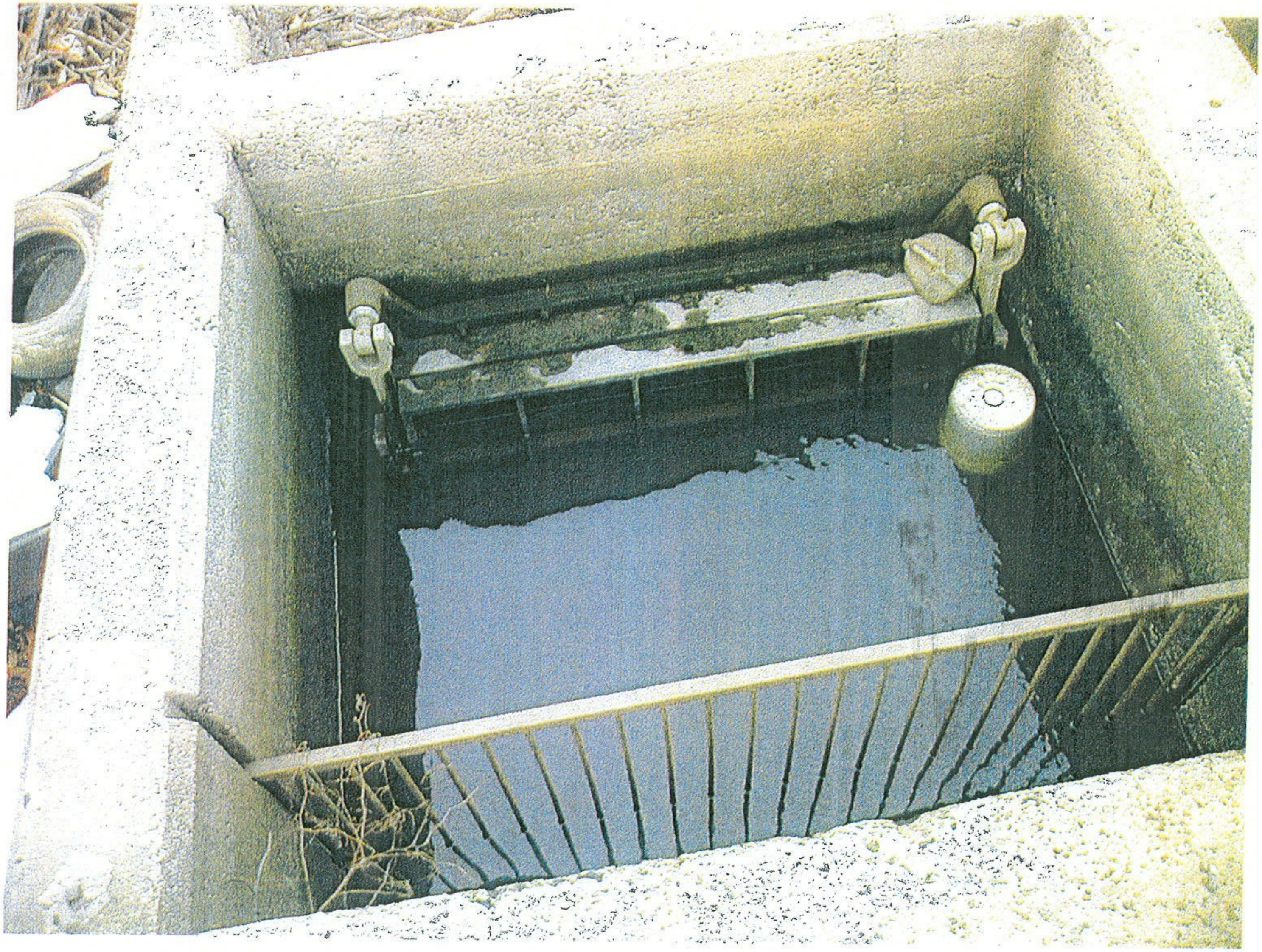


Photo No. 5

Looking down at the existing tide gate structure, located on the north side of the United New Jersey Railroad and Canal-Pennsylvania Railroad, Conrail Co. tracks

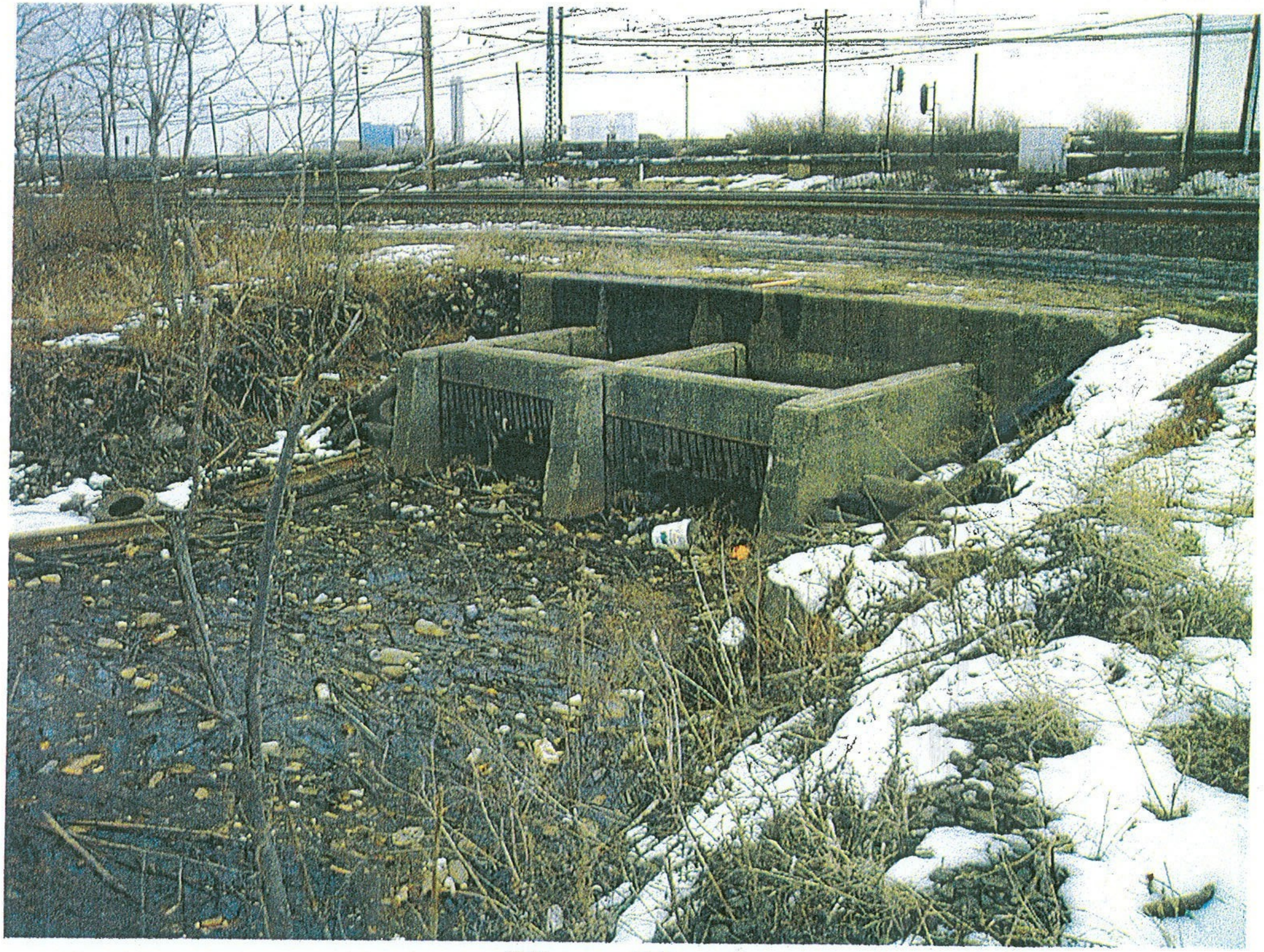


Photo No. 6

Looking south at the existing tide gates structure, located on the north side of the Unitec
New Jersey Railroad And Canal-Pennsylvania Railroad, Conrail Co. tracks

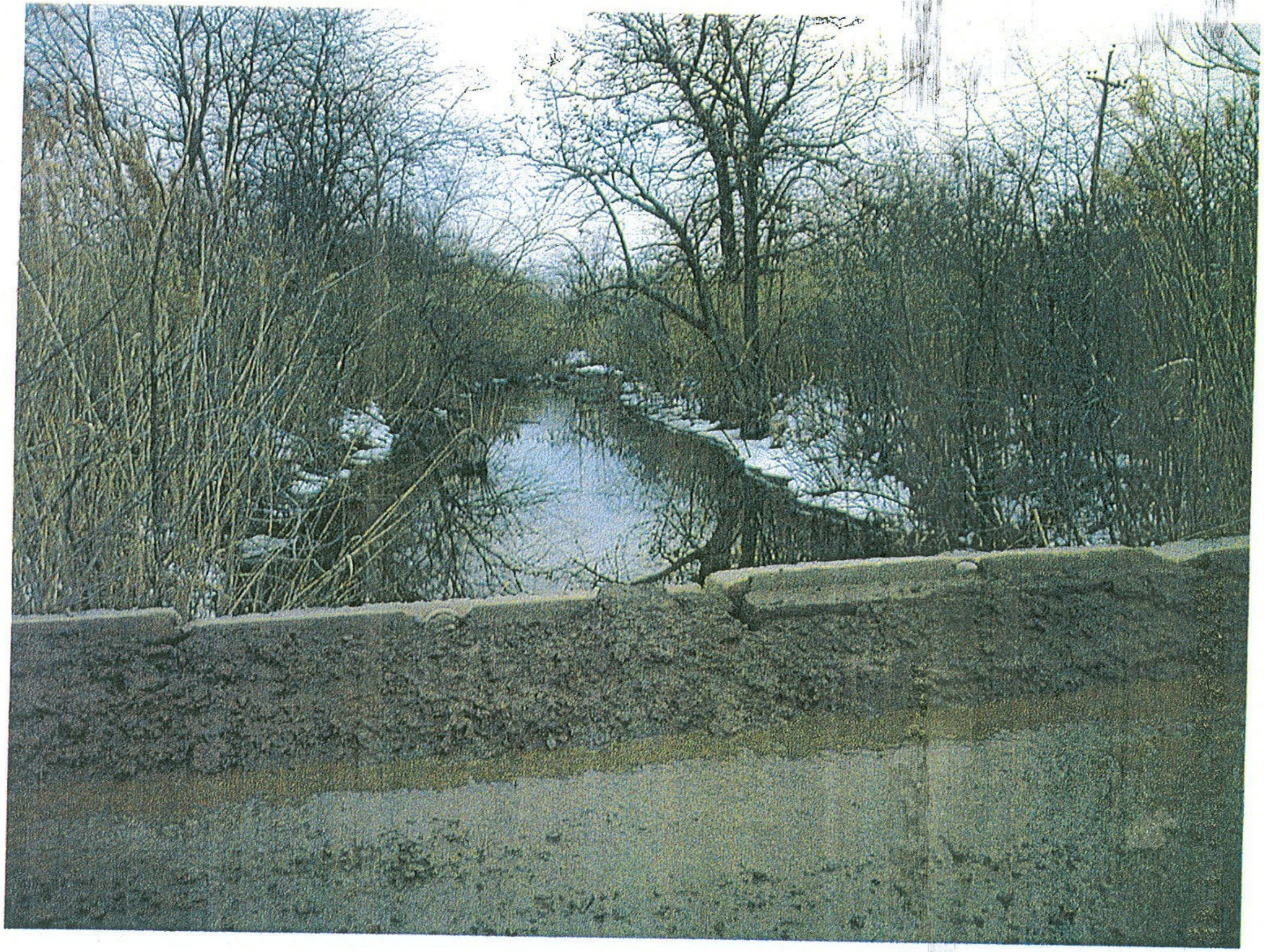


Photo No. 7

Looking south along Frank's Creek, from the Erie Lackawanna Railroad Co., Newark and Hudson Branch tracks

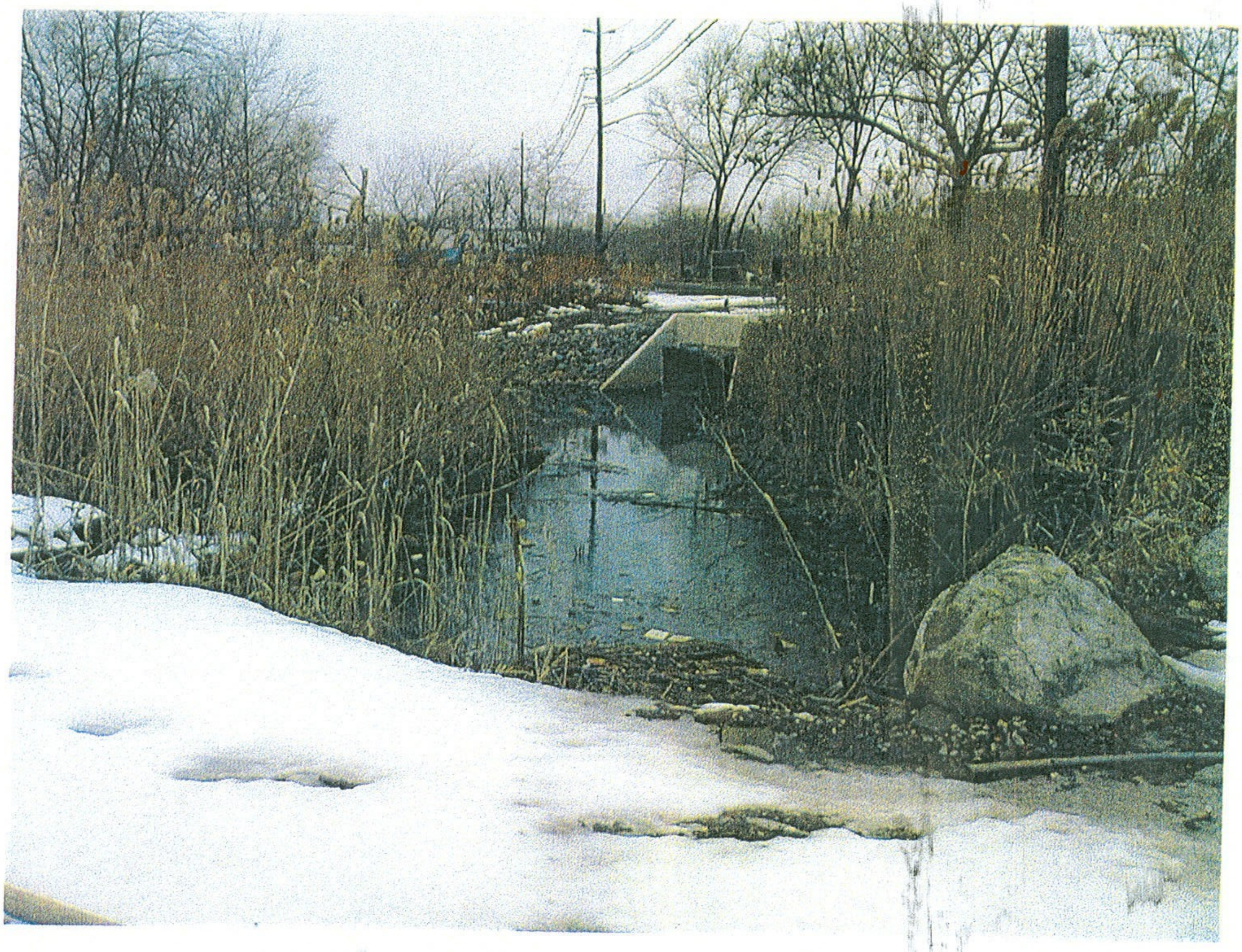


Photo No. 8

Looking north-west along Dead Horse Creek, at the newly installed tide gate and headwall on Bergen Avenue

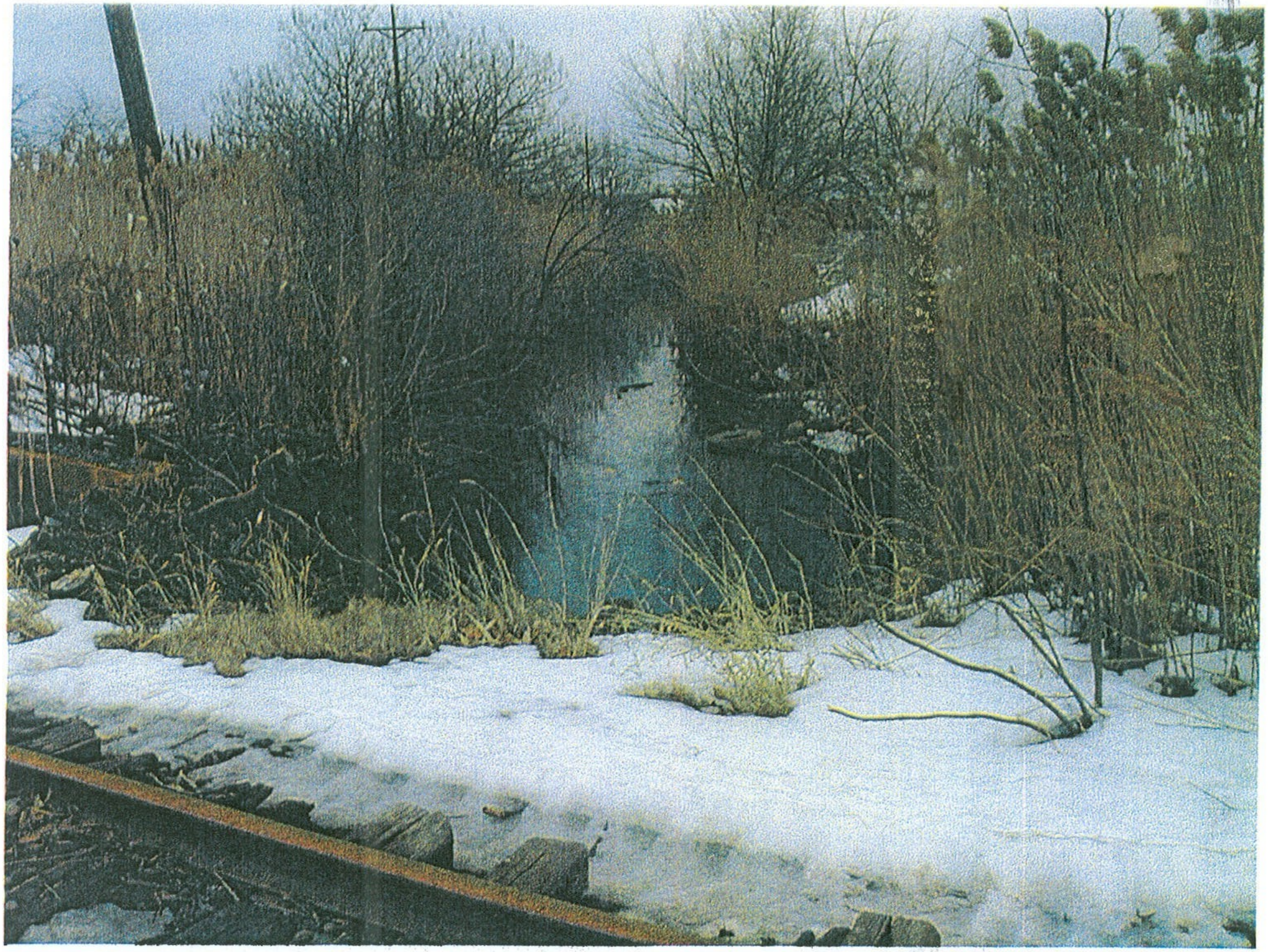


Photo No. 9

Looking south-east along Dead Horse Creek, from the Erie Lackawanna Railroad Co., Newark and Hudson branch tracks

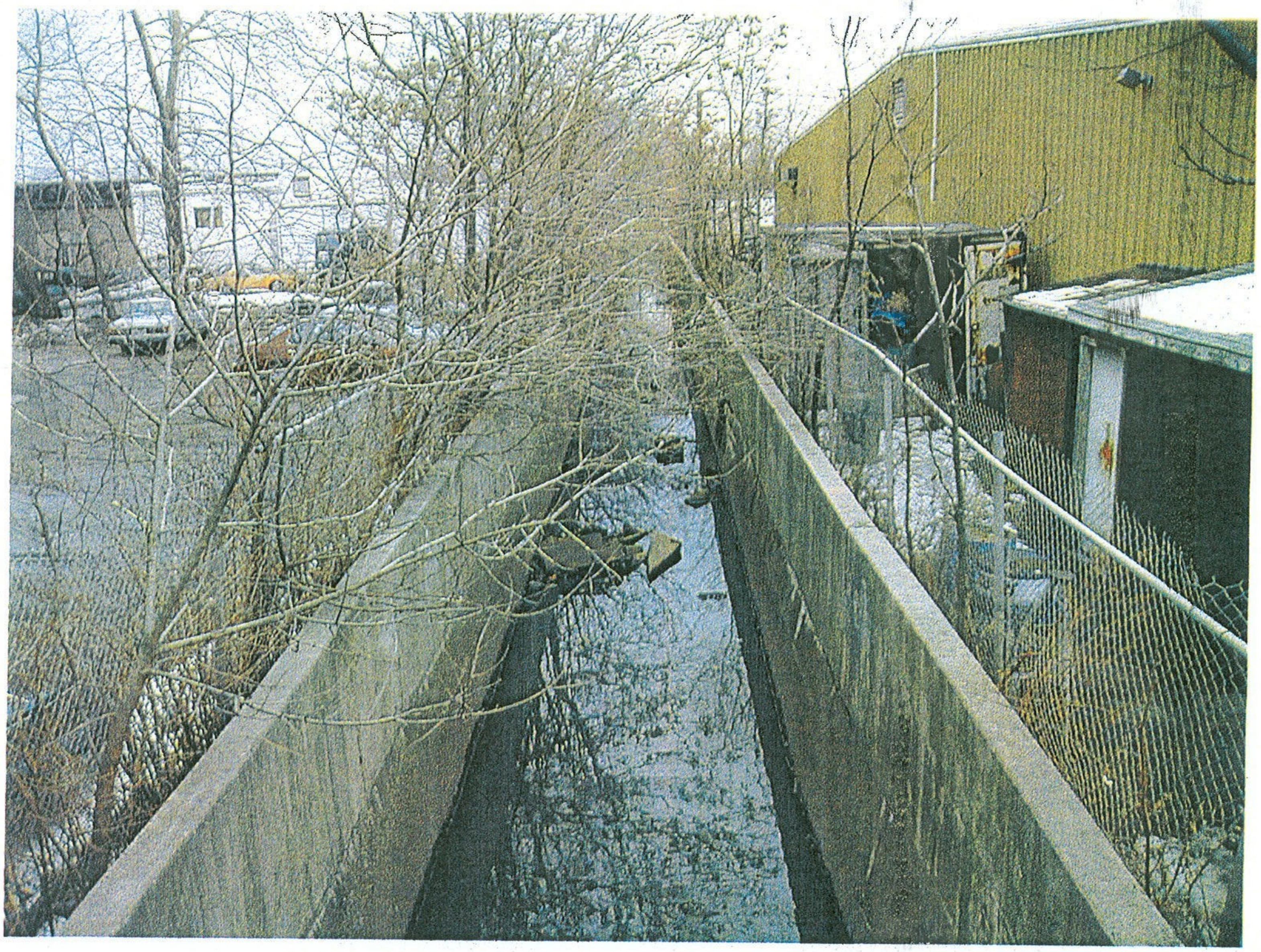


Photo No. 10

Looking east along the existing John Hay Avenue flume

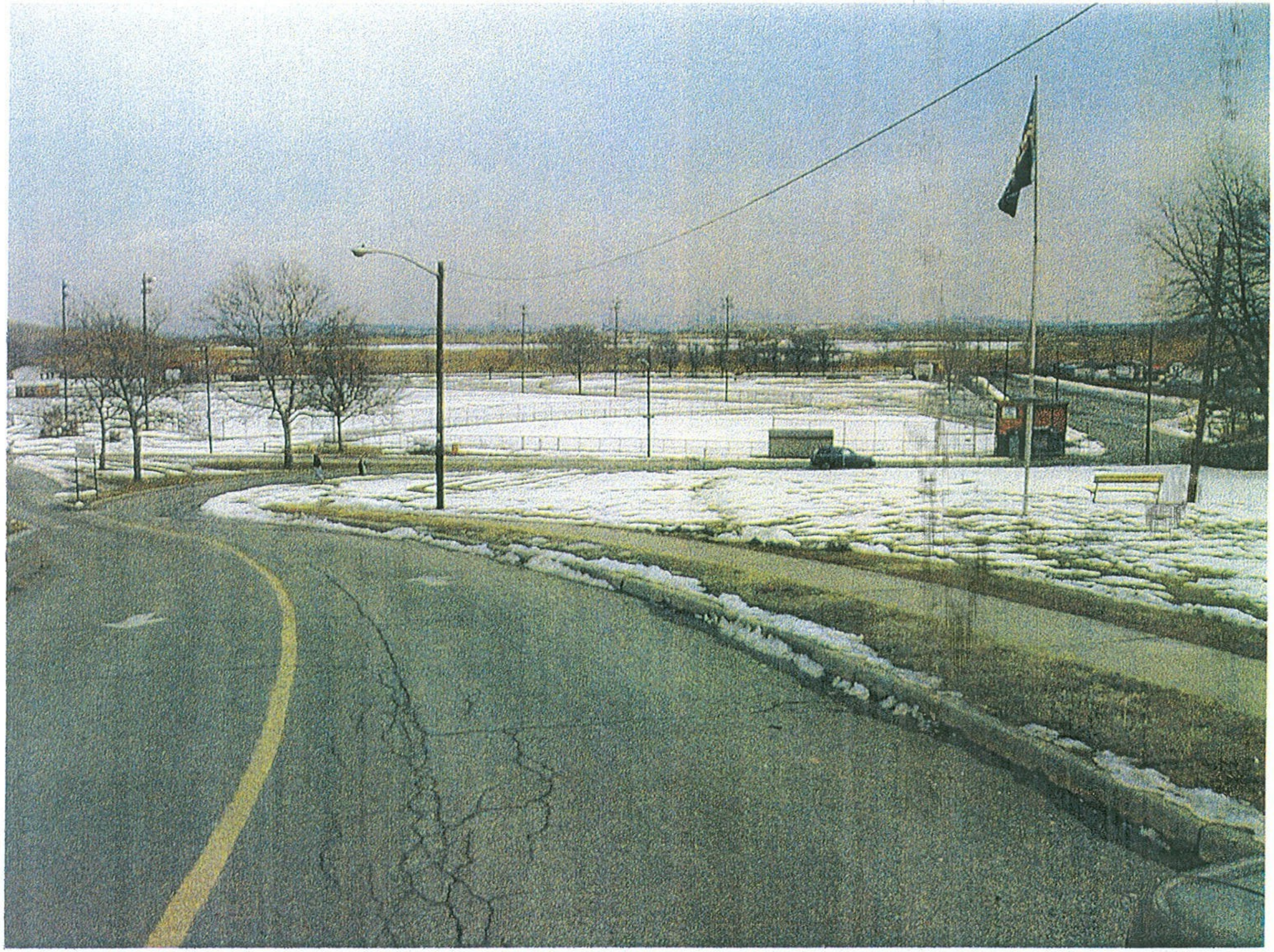


Photo No. 11

Looking east along the entrance road to the Gunnel Oval athletic complex. The Kearny Marsh is shown in the background

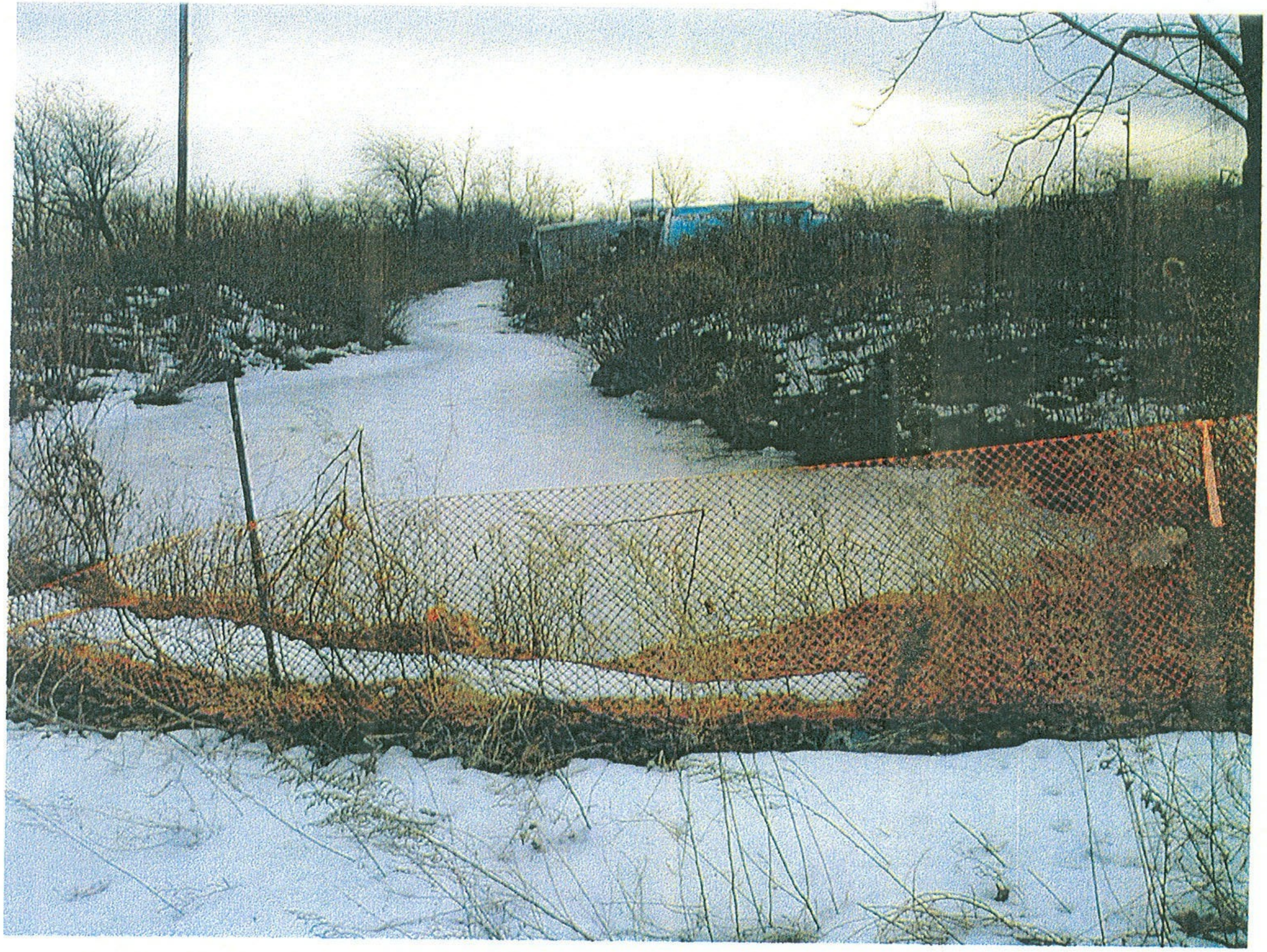


Photo No. 12

Looking south along the drainage swale at the Gunnel Oval, in the area of the proposed pump station

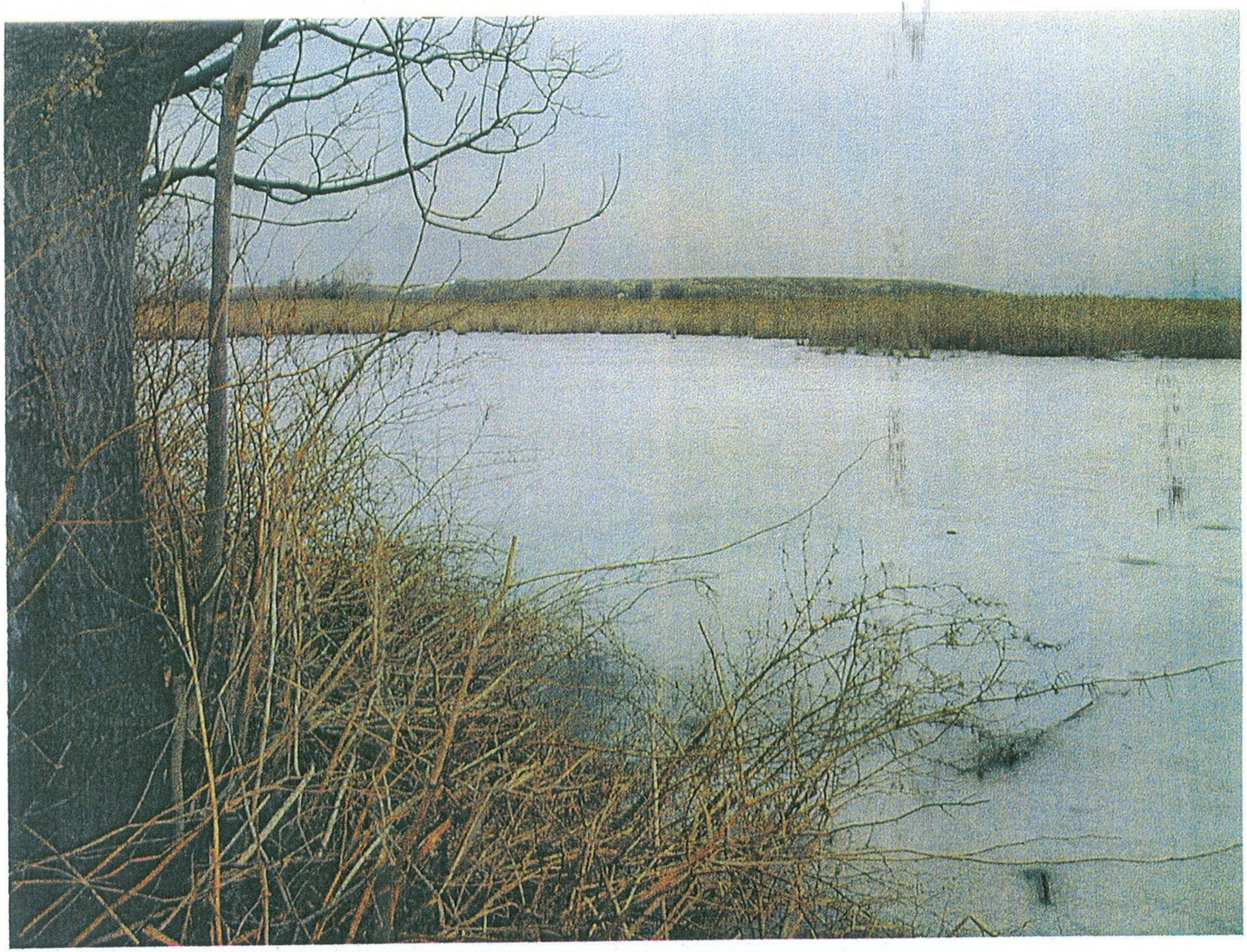


Photo No. 13

Looking north at the Kearny Marsh, from the Gunnel Oval side

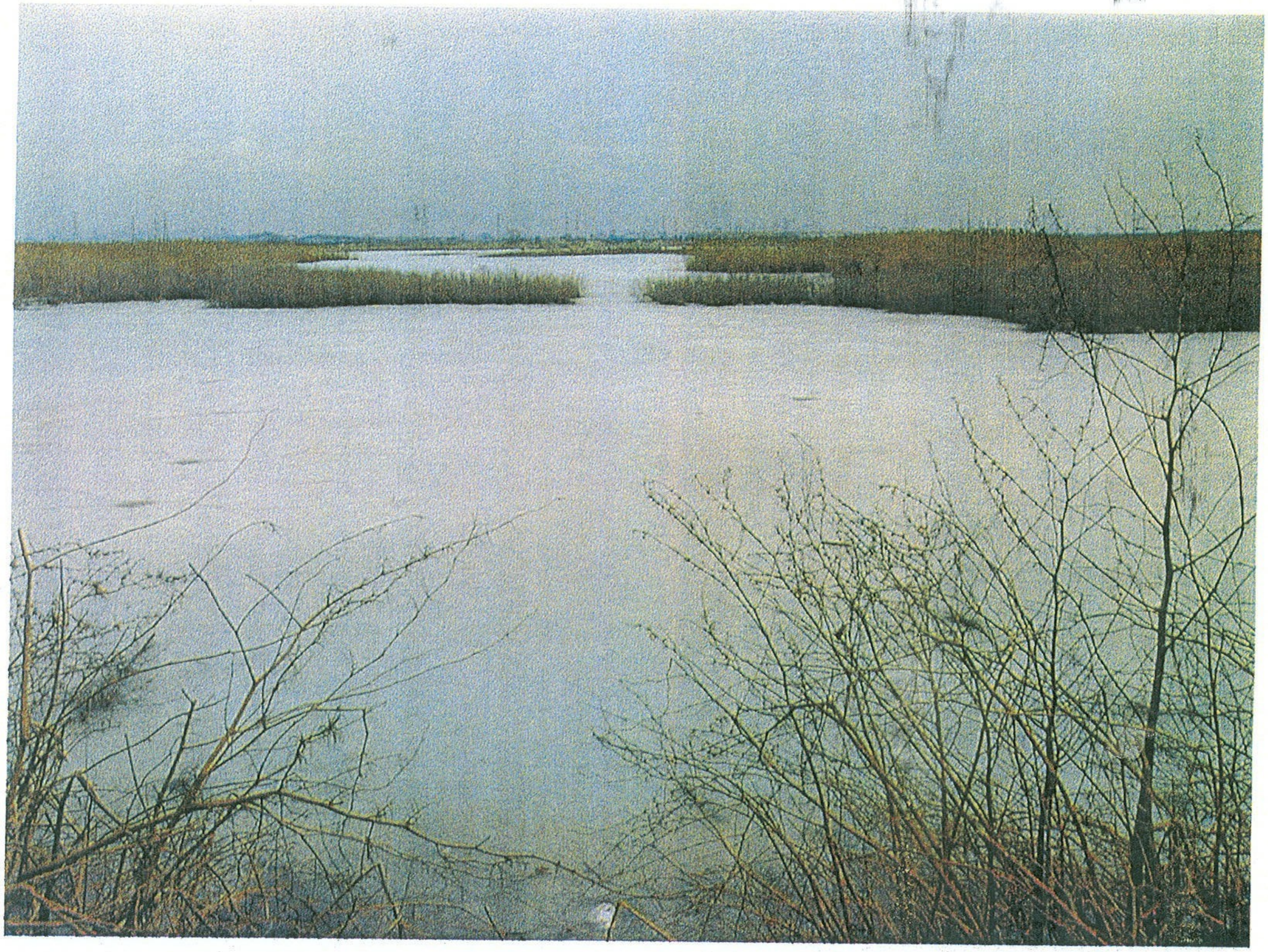


Photo No. 14
Looking east at the Kearny Marsh, from the Gunnel Oval side

Photo No. 15

Looking south at the Kearny Marsh, from the Gunnel Oval side

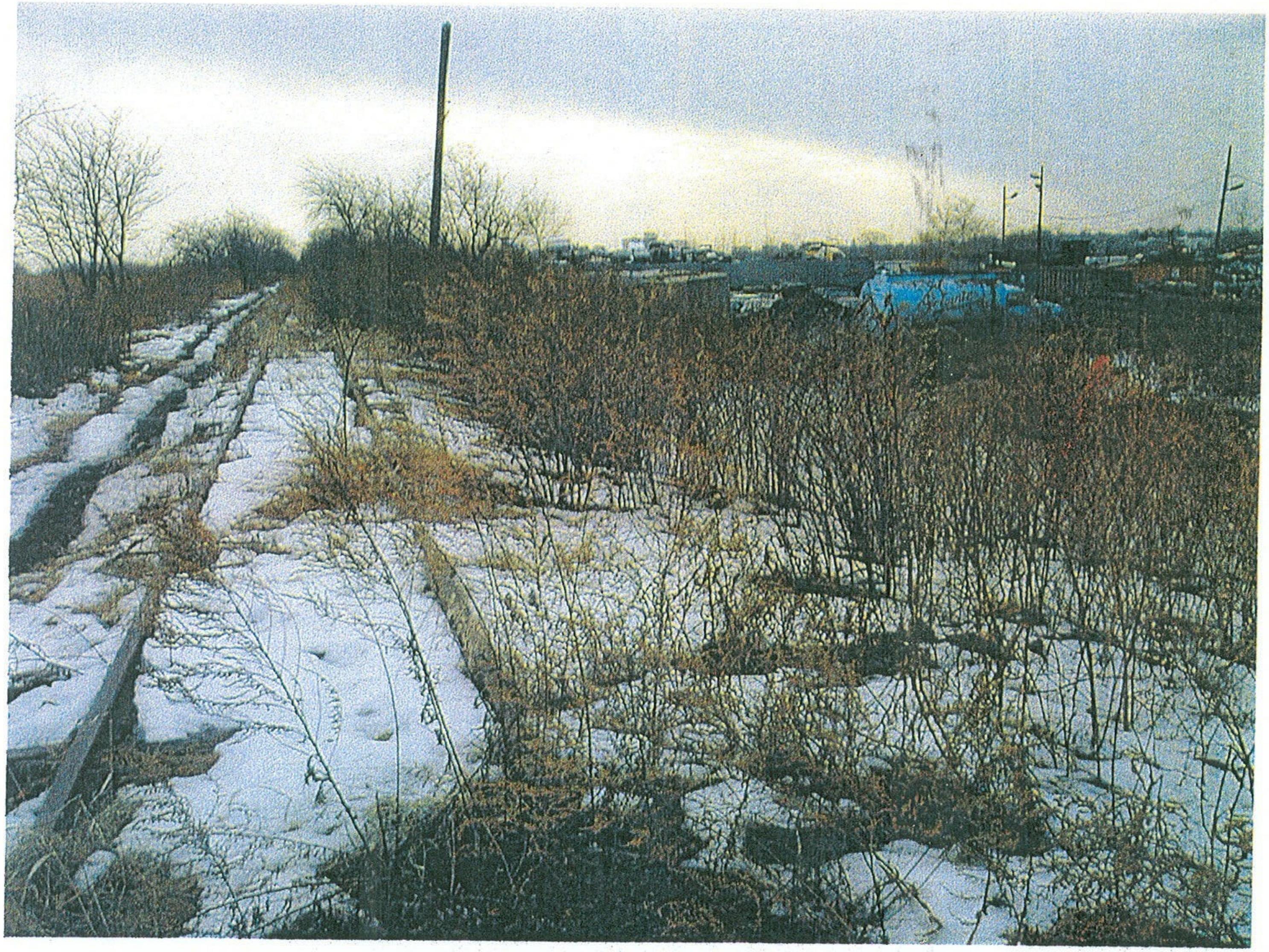


Photo No. 16

Looking south from the Gunnel Oval, along the Erie Lackawanna Railroad, Harrison anc
Kingsland Connecting Branch tracks

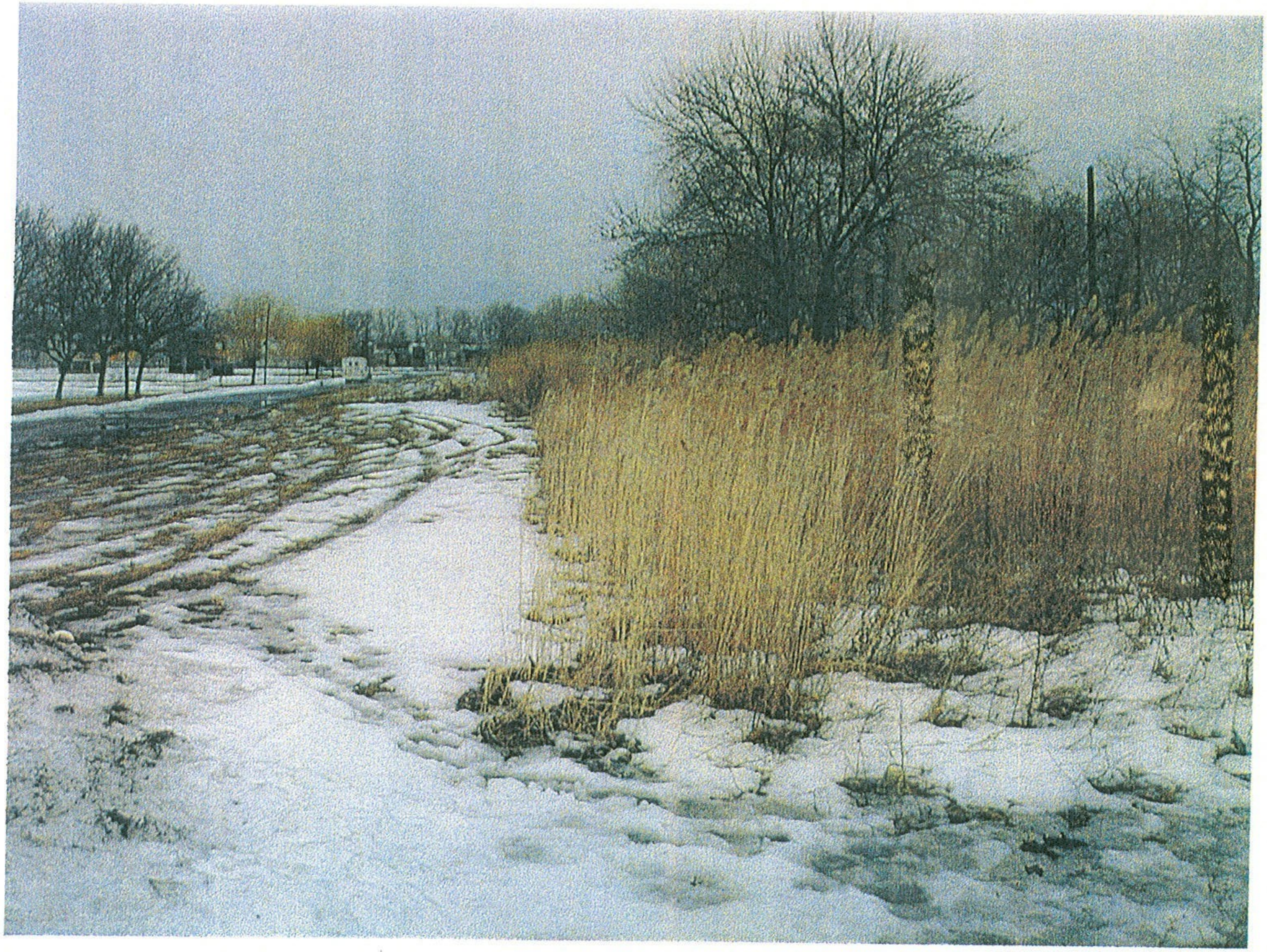


Photo No. 17
Looking north at the former drainage swale located east of the Gunnel Oval athletic complex. This area was recently filled

TABLE 3

KEARNY DRAINAGE STUDY AND ANALYSIS

DRAINAGE IMPROVEMENT COSTS

DEAD HORSE CREEK SYSTEM

Item	Description	Quantity	Unit	Cost	Amount
1	Portions of Phase IIB & IIC Improvements (2001)	1.00	L.S.	$2,300,000.00	$2,300,000.00
2	Remaining Phase IIA, IIB, IIC Improvements (Future)	1.00	L.S.	$3,400,000.00	$3,400,000.00
3	Dredge Dead Horse Creek	10,000.00	C.Y.	$50.00	$500,000.00
4	Gabion Sidewalls (Sect B-B)	2,000.00	C.Y.	$150.00	$300,000.00
5	4'H X 20' W X 50'L Box Culvert w/piles	1.00	Ea.	$1,000,000.00	$1,000,000.00
6	Floatables Separation Chamber	1.00	L.S.	$500,000.00	$500,000.00
	Subtotals				$8,000,000.00
	Contingency 20%				$1,600,000.00
	Total				$9,600,000.00

TABLE 4

KEARNY DRAINAGE STUDY AND ANALYSIS

DRAINAGE IMPROVEMENT COSTS

BERGEN AVENUE SYSTEM

Item	Description	Quantity	Unit	Cost	Amount
1	Floatables Separation Chamber	1.00	L.S.	$500,000.00	$500,000.00
	Subtotals				$500,000.00
	Contingency 20%				$100,000.00
	Total				$600,000.00

TABLE 5

KEARNY DRAINAGE STUDY AND ANALYSIS

DRAINAGE IMPROVEMENT COSTS

FRANK'S ~~DEAD HORSE~~ CREEK SYSTEM

Item	Description	Quantity	Unit	Cost	Amount
1	Tide Gates & Headwall	1.00	L.S.	$1,000,000.00	$1,000,000.00
2	Floatables Separation Chamber	1.00	L.S.	$500,000.00	$500,000.00
3	Dredge Frank's Creek (Sect A-A)	10,000.00	C.Y.	$100.00	$1,000,000.00
4	Concrete Lined Channel	6,000.00	C.Y.	$500.00	$3,000,000.00
5	Dredge Frank's Creek (Sect C-C)	20,000.00	C.Y.	$50.00	$1,000,000.00
6	Gabion Sidewall (Sect C-C)	8,000.00	C.Y.	$150.00	$1,200,000.00
7	Pump Station (3-60,000 GPM)	1.00	L.S.	$4,000,000.00	$4,000,000.00
8	5' H X 15' W X 50' L Box Culverts w/piles	2.00	Ea.	$1,000,000.00	$2,000,000.00
9	5' H X 15' W X 250' L Box Culvert w/piles	1.00	L.S.	$2,000,000.00	$2,000,000.00
10	6'H X 15'W X 550' L Box Culvert w/piles	1.00	L.S.	$3,000,000.00	$3,000,000.00
11	Outflow Control structure	1.00	Ea.	$250,000.00	$250,000.00
12	Dredge Sections E-E	20,000.00	C.Y.	$50.00	$1,000,000.00
13	Gabion Sidewalls (Section E-E)	7,000.00	C.Y.	$150.00	$1,050,000.00
	Subtotals				$21,000,000.00
	Contingency 20%				$4,200,000.00
	Total				$25,200,000.00

TABLE 6

KEARNY DRAINAGE STUDY AND ANALYSIS

DRAINAGE IMPROVEMENT COSTS

GUNNEL OVAL SYSTEM

Item	Description	Quantity	Unit	Cost	Amount
1	Pump Station (2-4,200 GPM, Force Main, Headwall & Tide Gate	1.00	L.S.	$2,500,000.00	$2,500,000.00
2	Dredge Section F-F	5000.00	C.Y.	$50.00	$250,000.00
3	4' X 15' X 800' Box Culvert	1.00	L.S.	$3,000,000.00	$3,000,000.00
4	4' X 15' X 250' Box Culvert	1.00	L.S.	$1,750,000.00	$1,750,000.00
5	Floatables Separation Chamber	1.00	L.S.	$500,000.00	$500,000.00
	Subtotals				$8,000,000.00
	Contingency 20%				$1,600,000.00
	Total				$9,600,000.00

TABLE 7

KEARNY DRAINAGE STUDY AND ANALYSIS

DRAINAGE IMPROVEMENT COSTS

KEARNY MARSH SYSTEM

Item	Description	Quantity	Unit	Cost	Amount
1	Outflow Control Structures	2.00	Ea.	$250,000.00	$500,000.00
2	Dredge Canals	20000.00	C.Y.	$100.00	$2,000,000.00
3	5'H X 5'W X 50'L Box Culvert	2.00	Ea.	$500,000.00	$1,000,000.00
	Subtotals				$3,500,000.00
	Contingency 20%				$700,000.00
	Total				$4,200,000.00

TABLE 8

KEARNY DRAINAGE STUDY AND ANALYSIS

DRAINAGE IMPROVEMENT COSTS

HARRISON AVENUE SYSTEM

Item	Description	Quantity	Unit	Cost	Amount
1	Tide Gates (s) & Headwall	1.00	L.S.	$500,000.00	$500,000.00
	Subtotals				$500,000.00
	Contingency 20%				$100,000.00
	Total				$600,000.00